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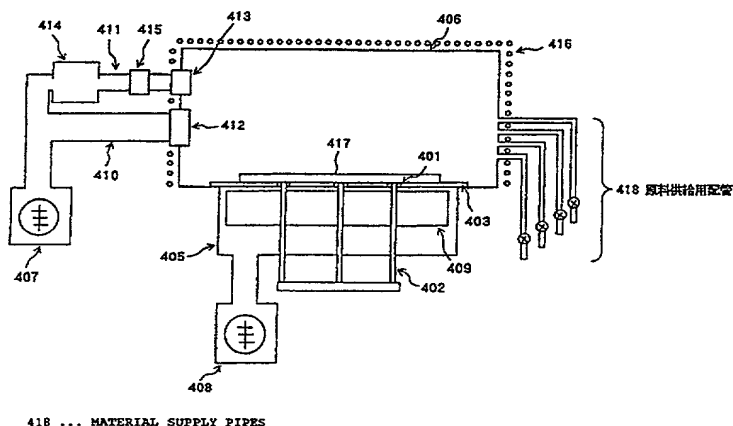
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(54)Title: VAPOR GROWTH METHOD FOR METAL OXIDE DIELECTRIC FILM AND VAPOR GROWTH DEVICE FOR METAL OXIDE DIELECTRIC MATERIAL

(54)発明の名称 金属酸化物誘電体膜の気相成長方法および金属酸化物誘電体材料の気相成長装置



(57) Abstract

A vapor growth method for a metal oxide dielectric film capable of forming on a plug a metallic oxide excellent in orientation and crystallinity at low temperature, comprising introducing an organic metal material gas and an oxidizing gas into a vacuum container from separate inlets while a substrate disposed in the vacuum container being heated and forming a film with a total pressure within the vacuum container kept at not higher than  $1 \times 10^{-2}$  Torr; the method further comprising, when forming a metal oxide dielectric film having a Perovskite type crystal structure, using different film forming conditions for a first film forming condition for forming an initial nucleus or an initial layer and a second film forming condition for growing a film of a Perovskite type crystal structure on the formed initial nucleus and selecting an optimum one of the conditions for film forming; and a vapor growth device for implementing the above vapor growth methods.

## ABSTRACT

The present invention relates to a vapor phase growth method of a metal oxide dielectric film and capable of forming a metal oxide with excellent in both orientation and crystallinity on a plug at a low temperature and carries out film formation by introducing the organometal gases and an oxidizing gas into a vacuum chamber through separate introduction inlets while heating the substrate set in the vacuum chamber at  $1 \times 10^{-2}$  Torr or lower of the total pressure of the vacuum chamber. Further, the present invention is for carrying out film formation of a metal oxide dielectric film with a perovskite type crystal structure by changing film formation conditions and properly selecting optimum conditions for first film formation conditions for initial nuclei or layer formation and second film formation conditions for film formation of the perovskite type crystal structure further on the formed initial nuclei. The present invention further relates to a vapor phase growth apparatus to be employed for the vapor phase growth methods.

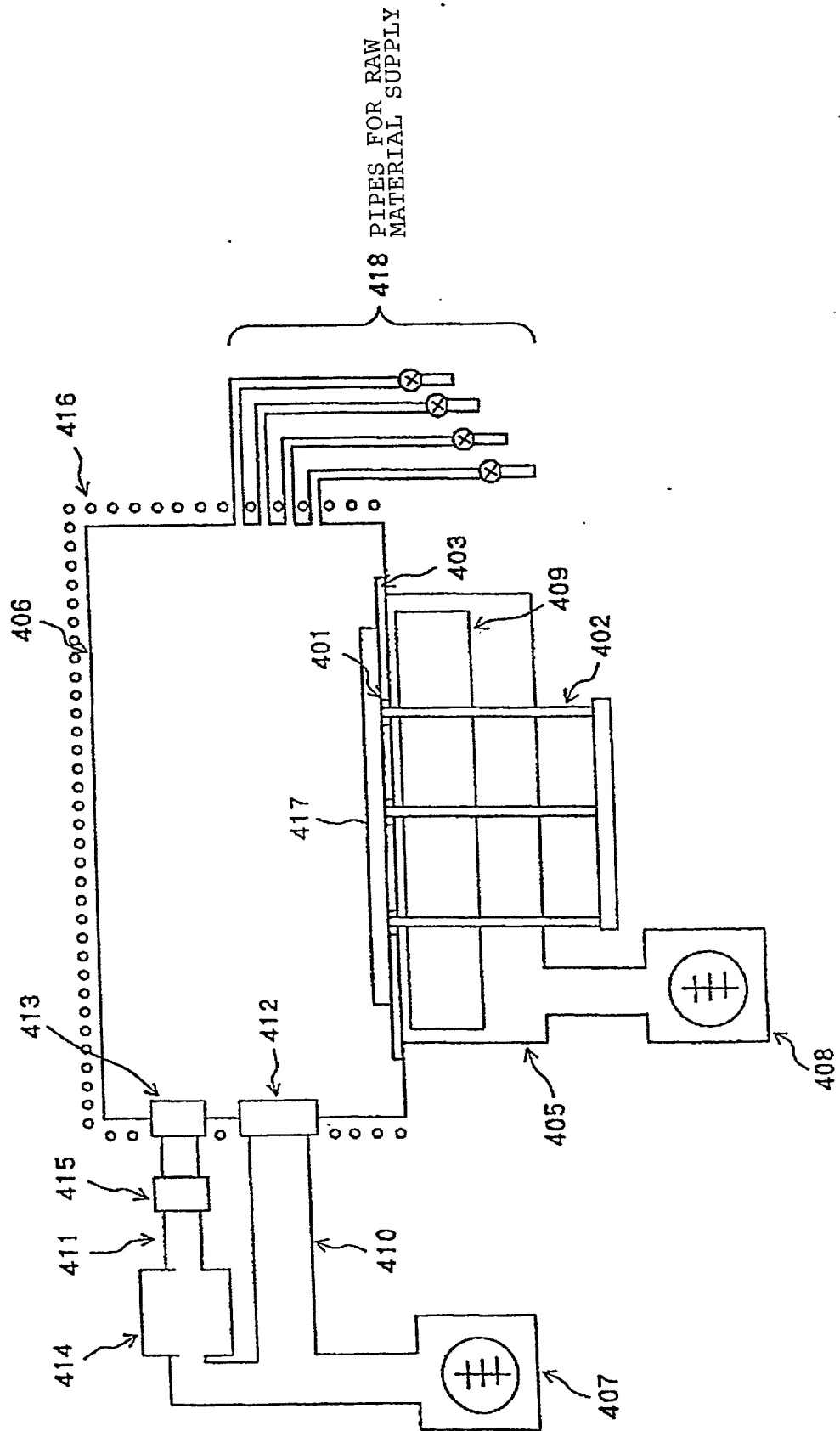
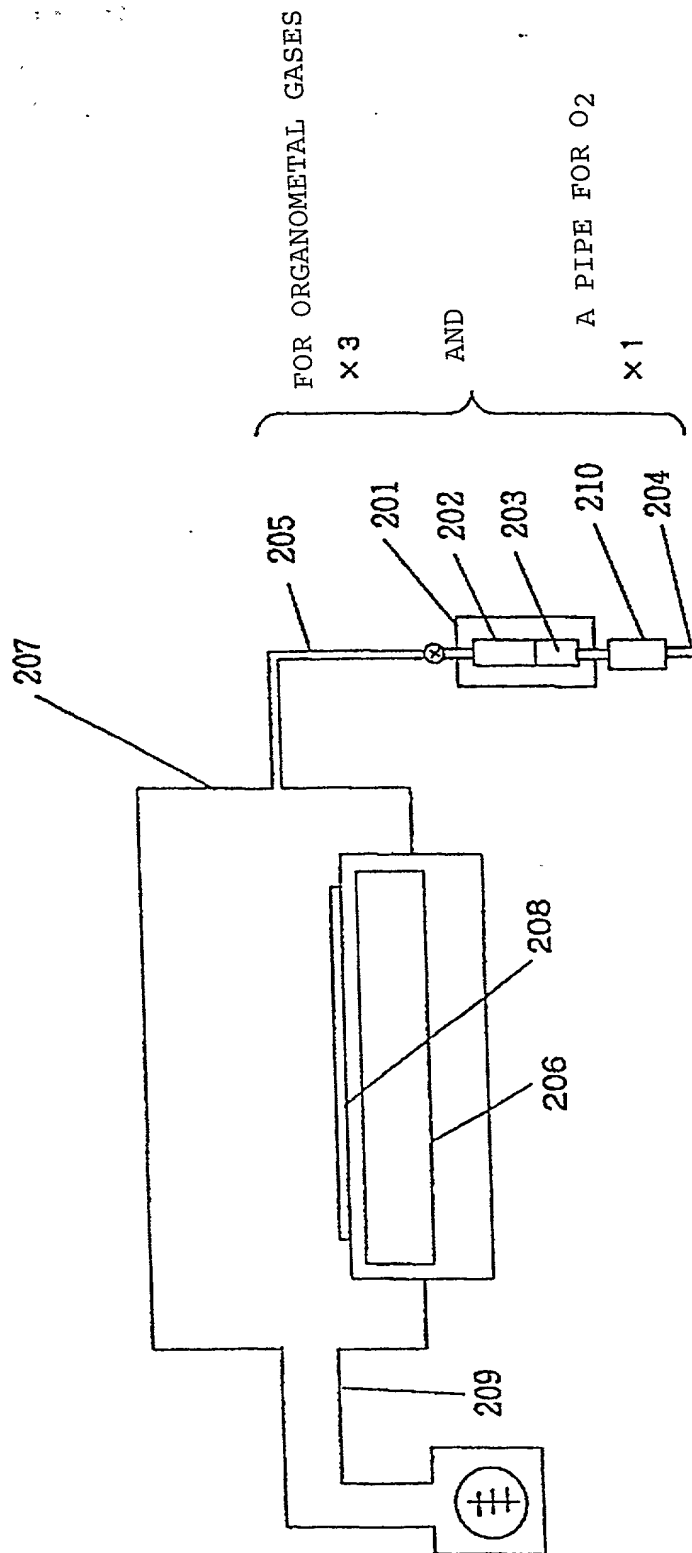


Fig. 2



FOOTNOTES

Fig. 3

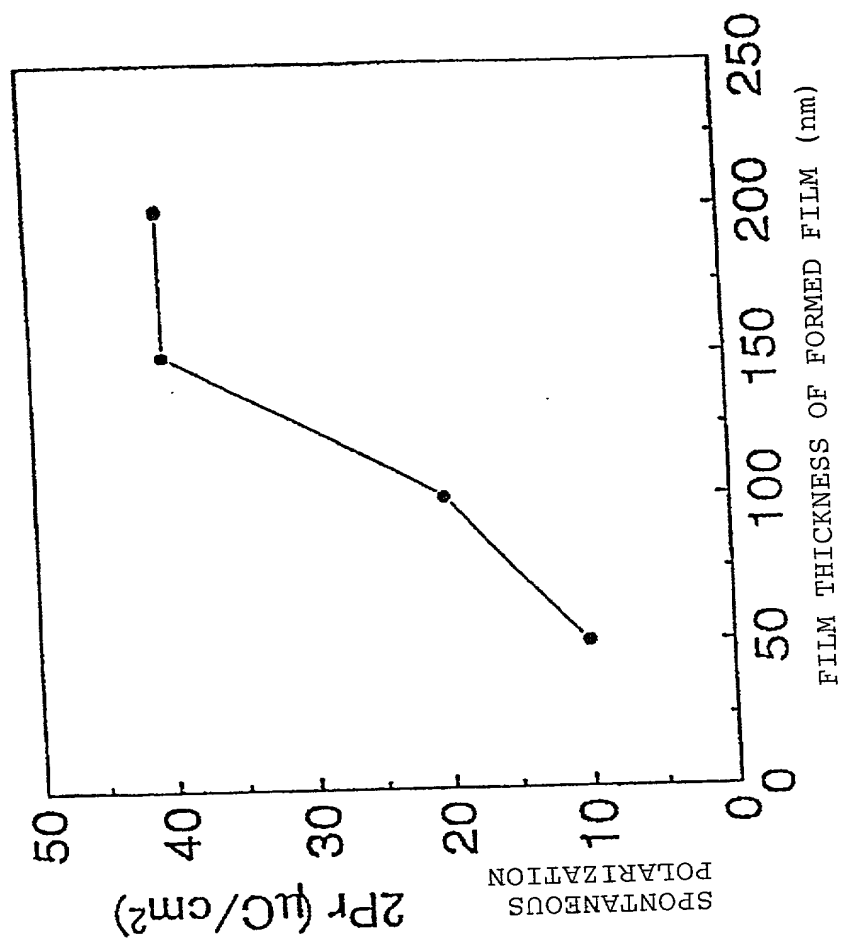


Fig. 4

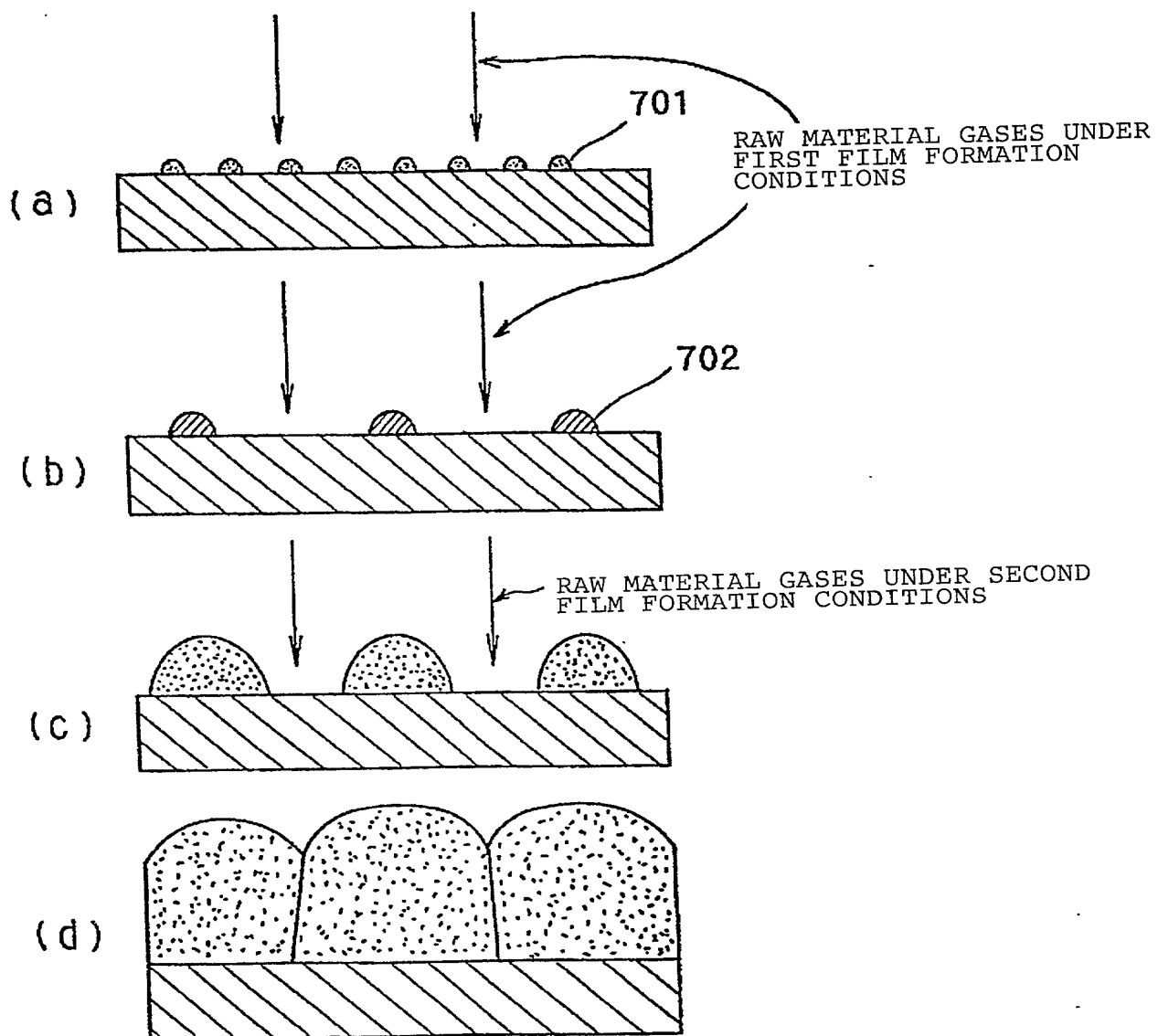
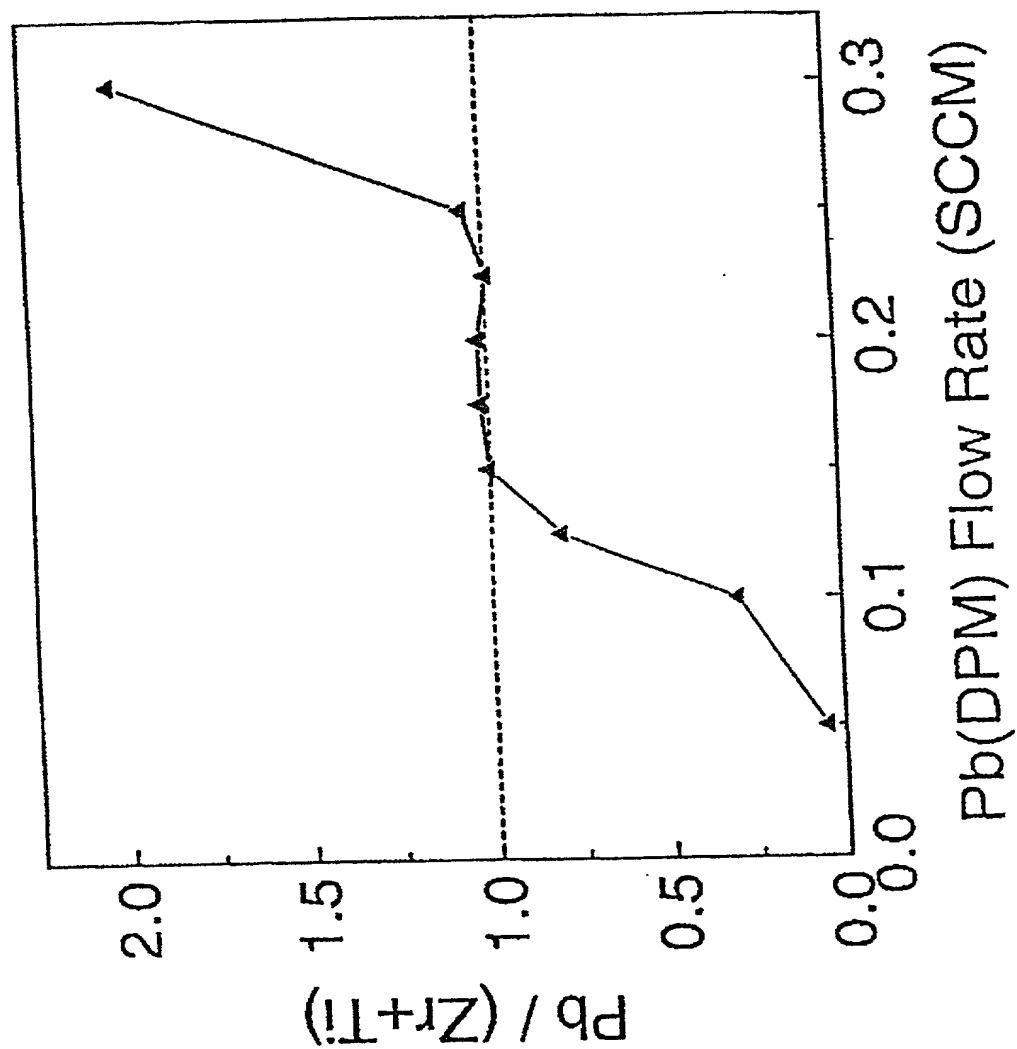


Fig. 5



[illegible]

Fig. 6

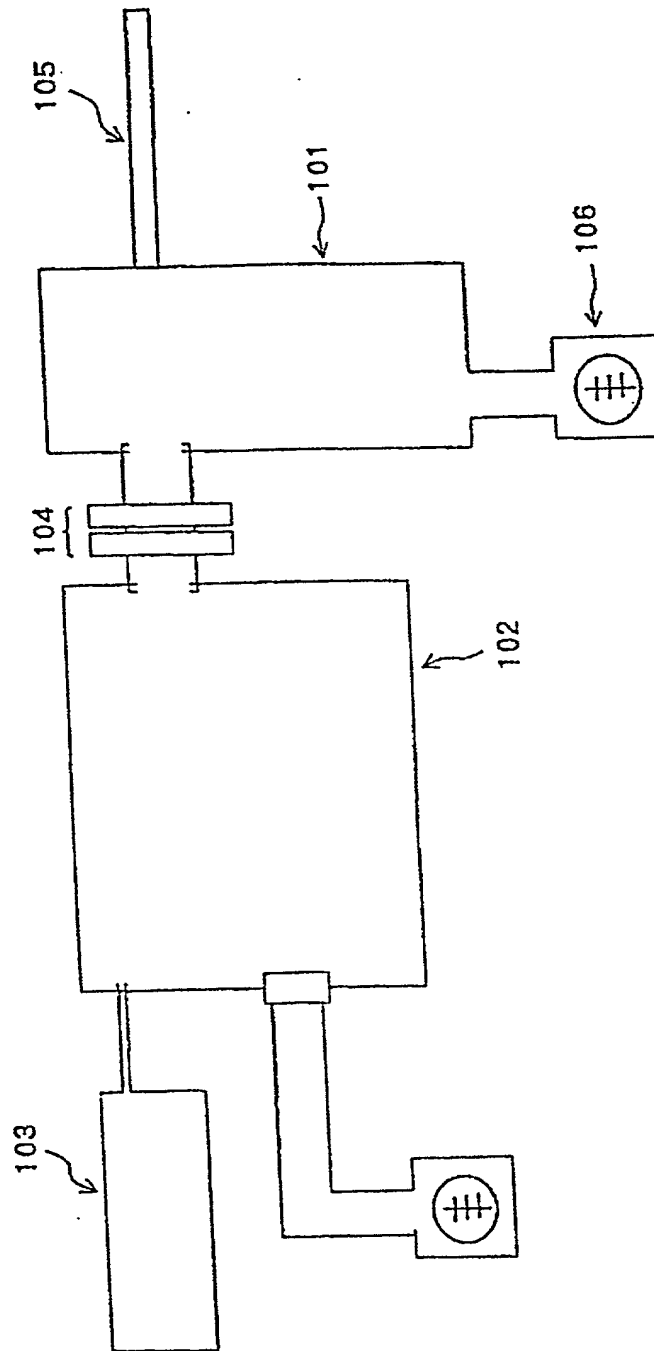
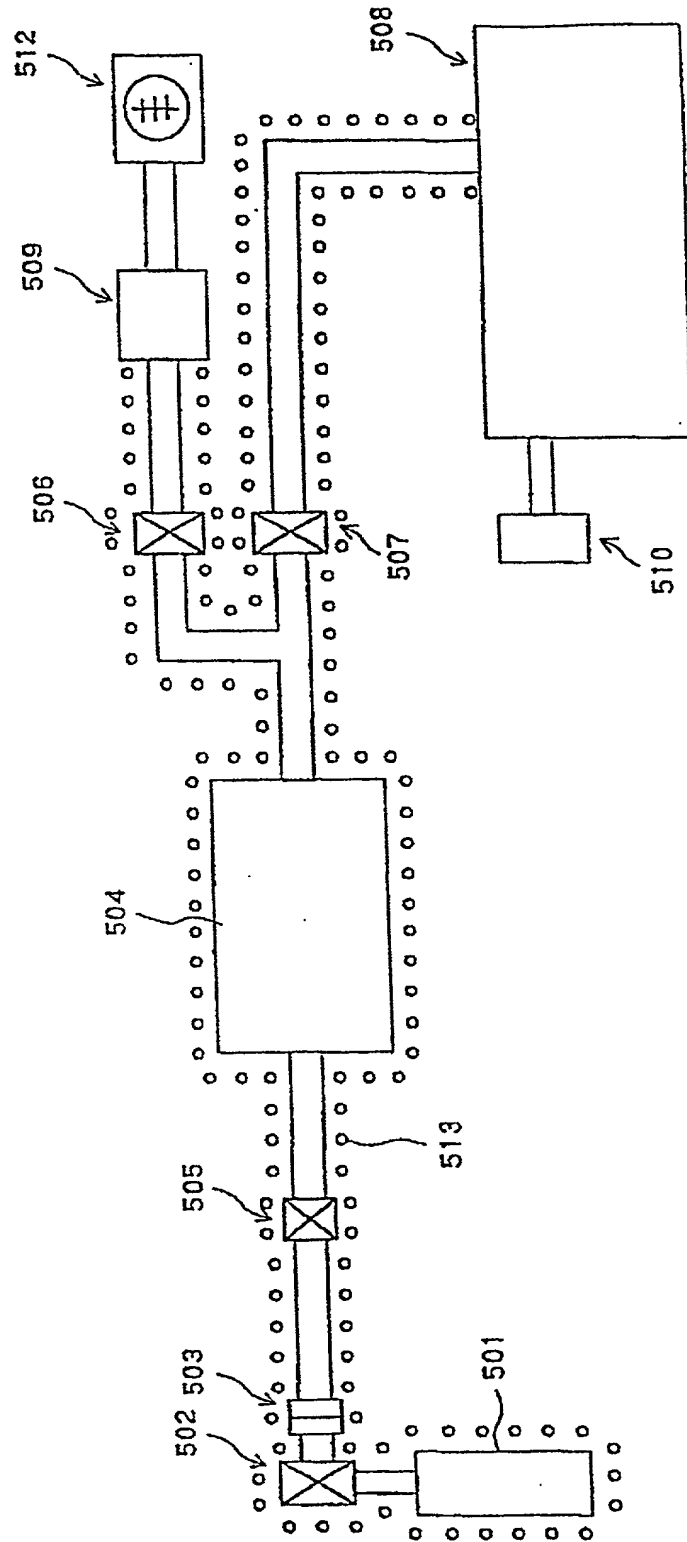




Fig. 7





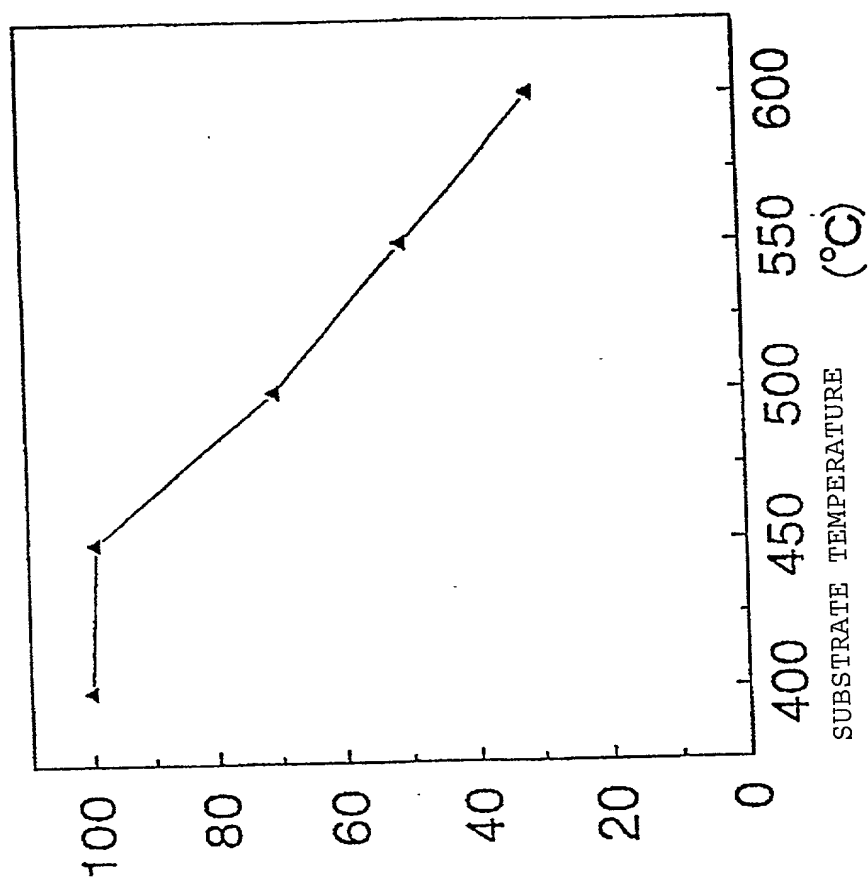


Fig. 9

RATIO (%) OF (100) CRYSTAL GRAIN

Fig. 10

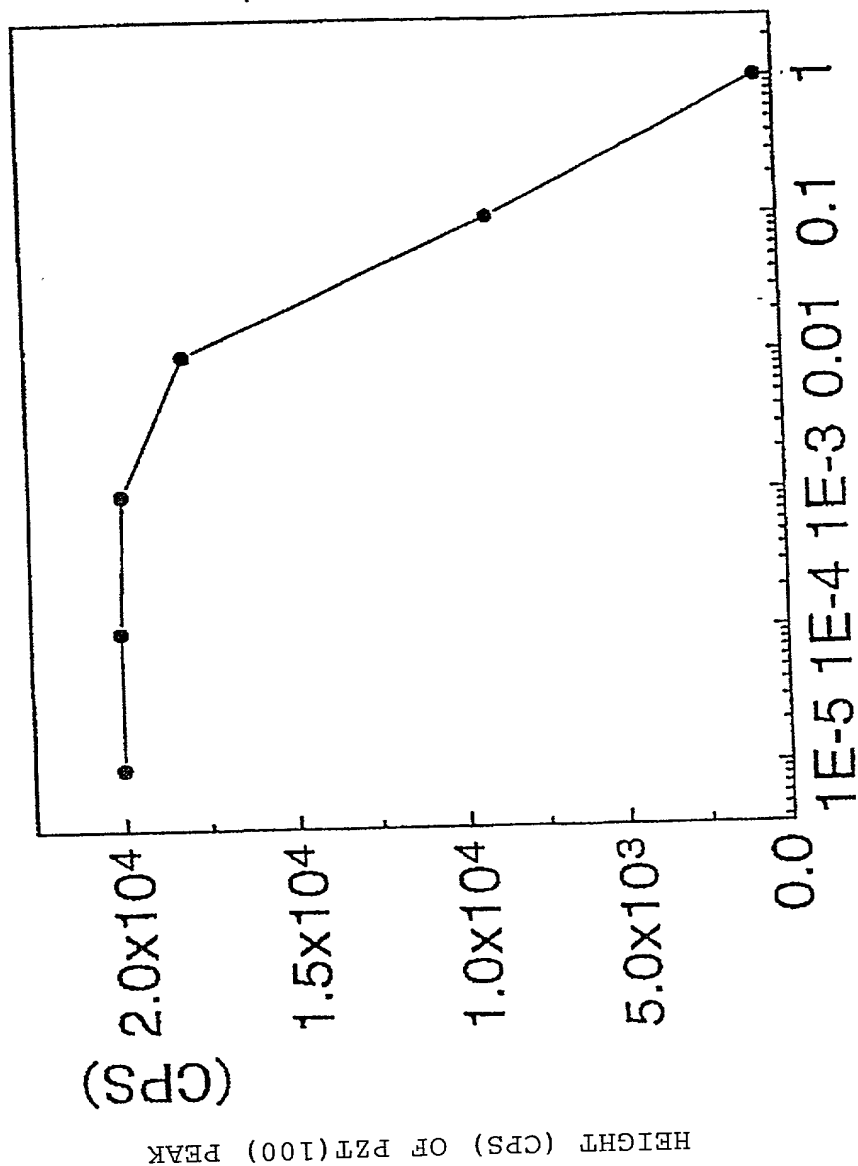
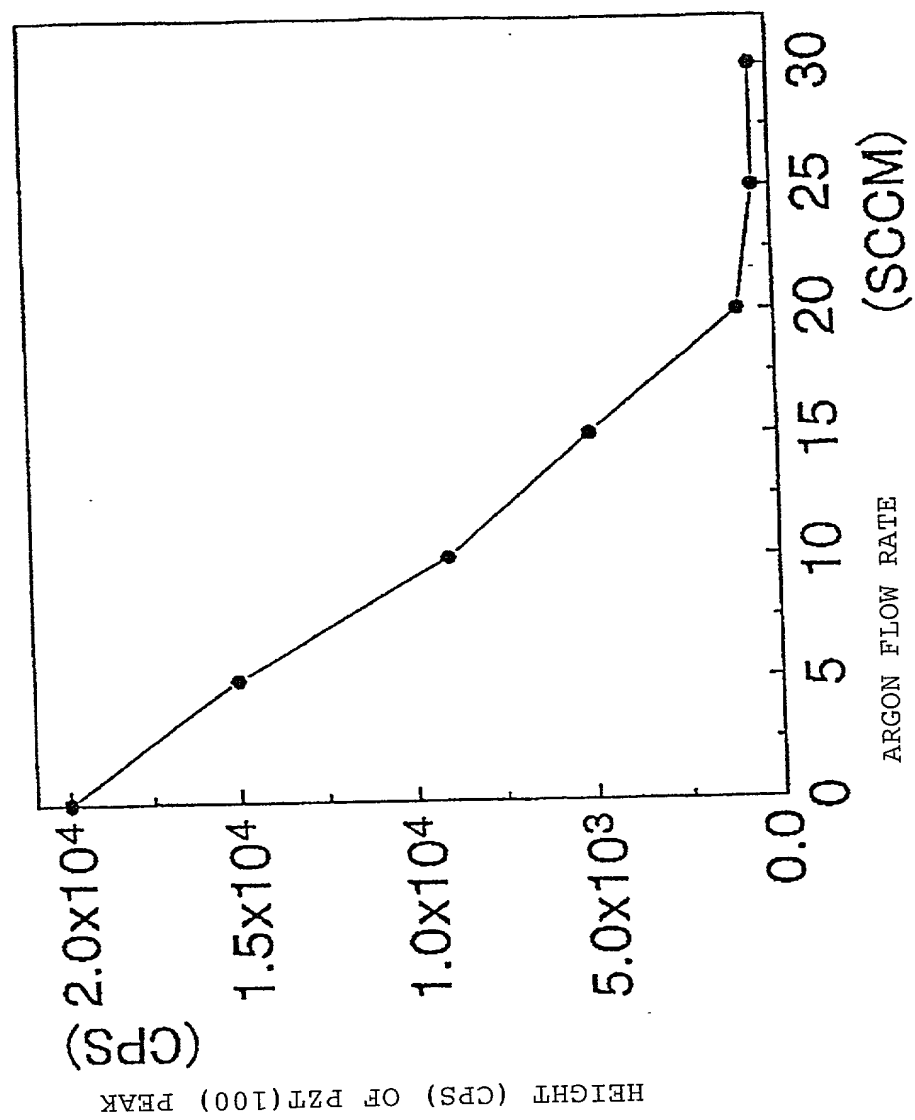


Fig. 11



FOOTNOTES

Fig. 12

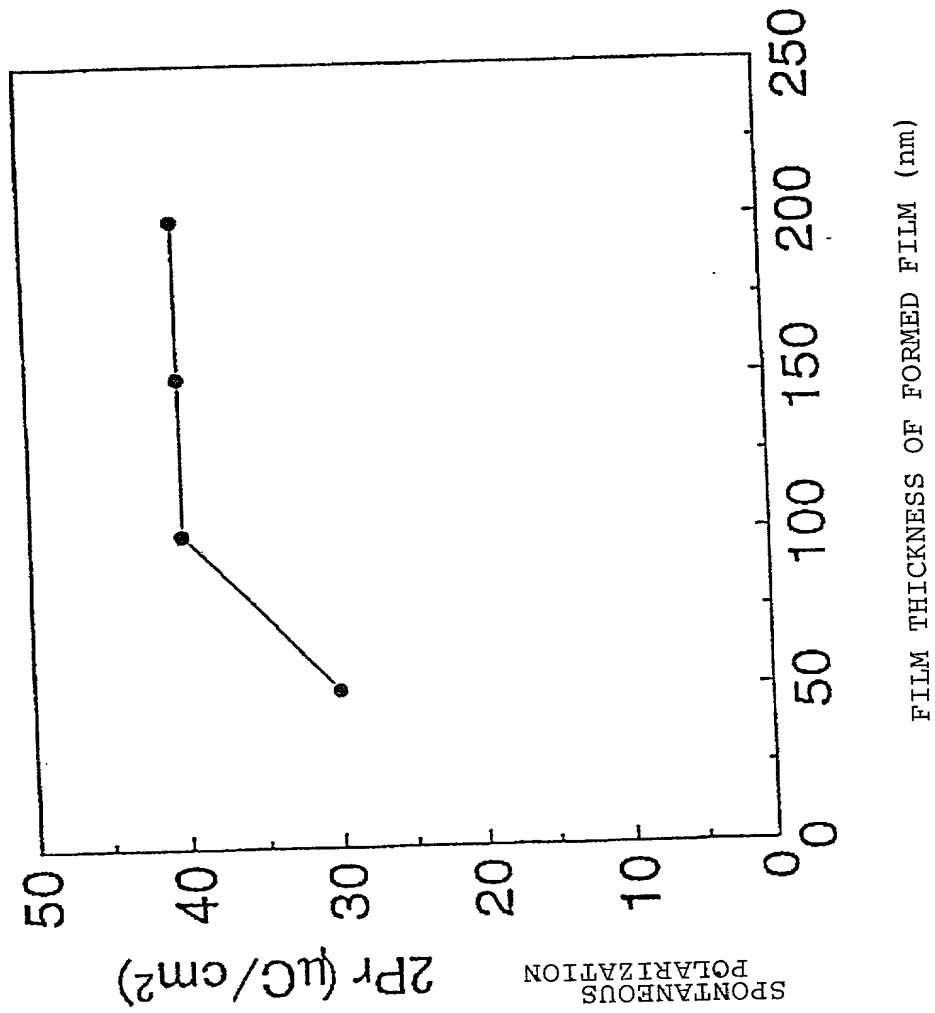
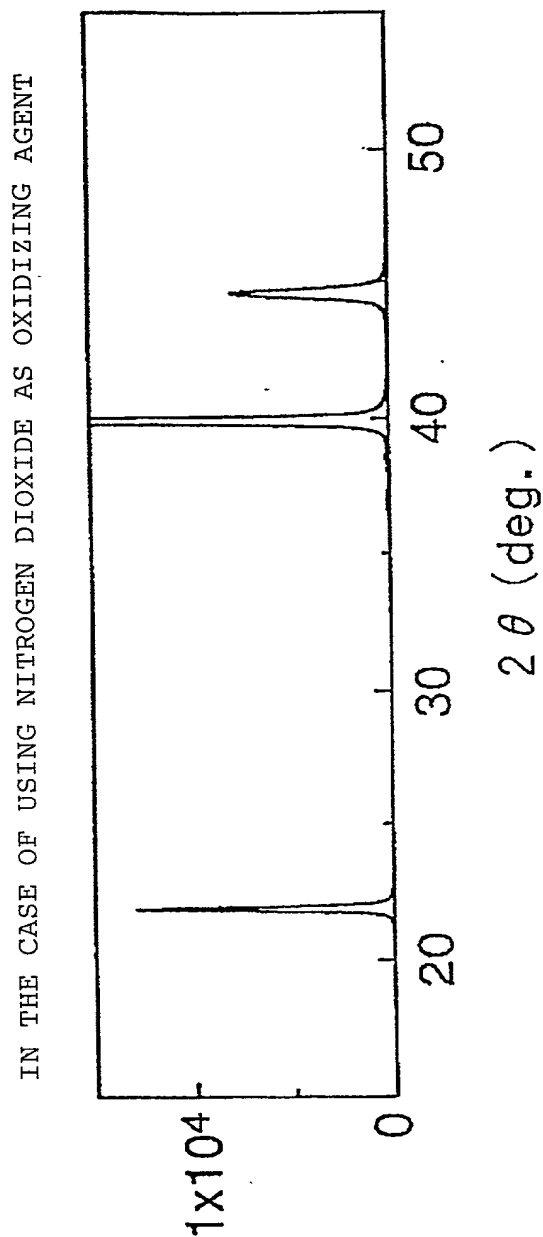
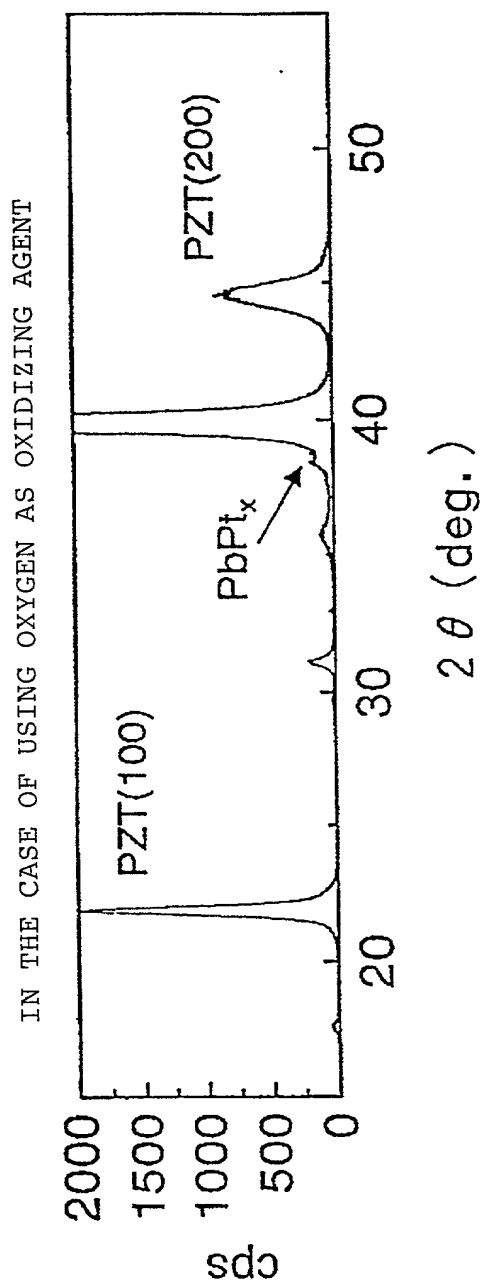
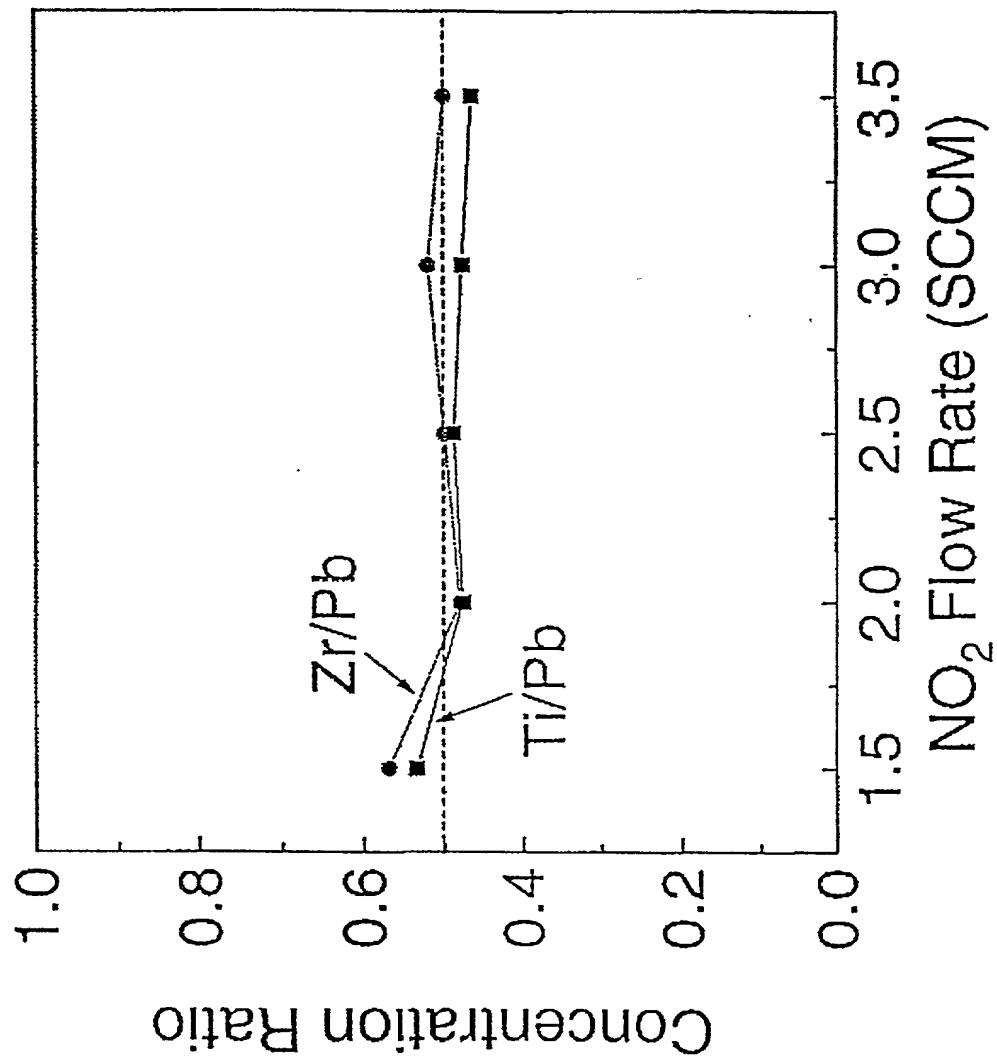


Fig. 13



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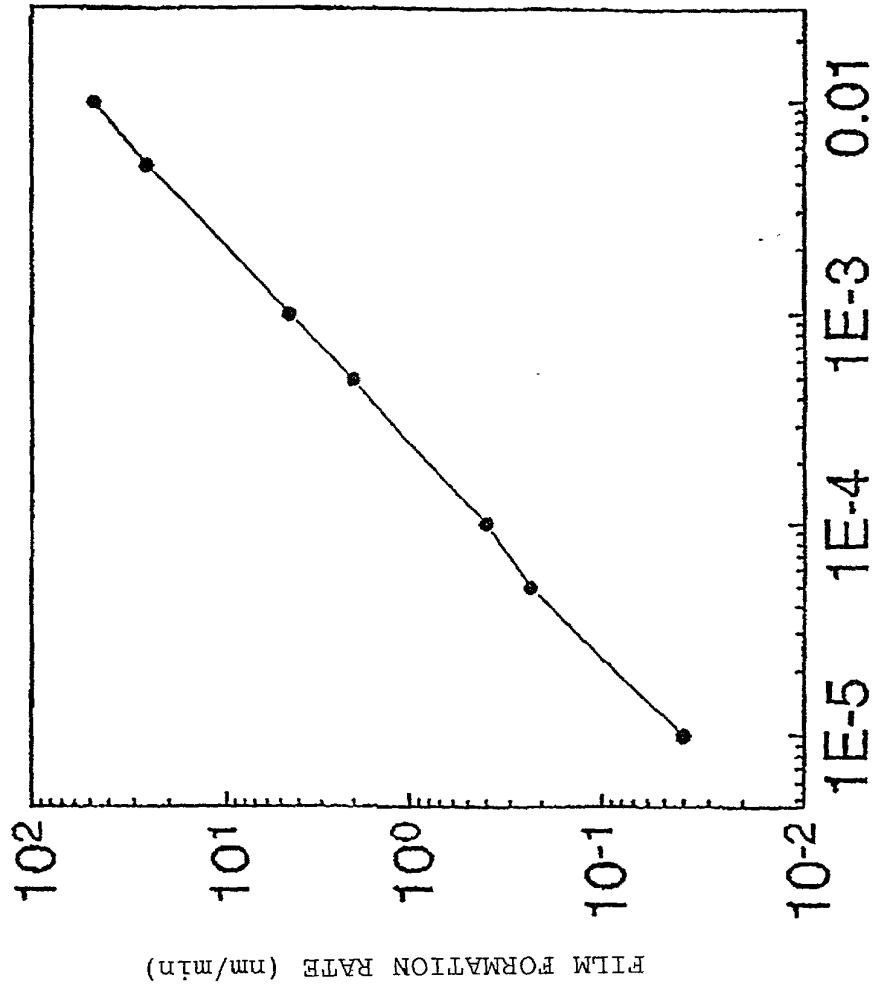
Fig. 14





FILM FORMATION

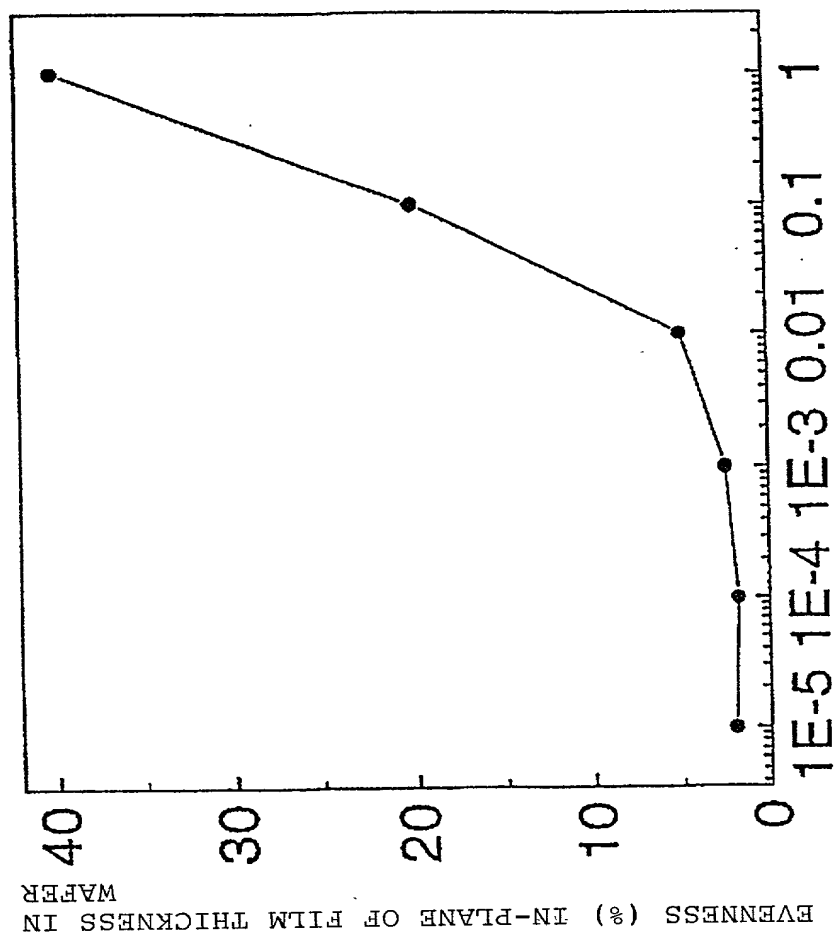
Fig. 15



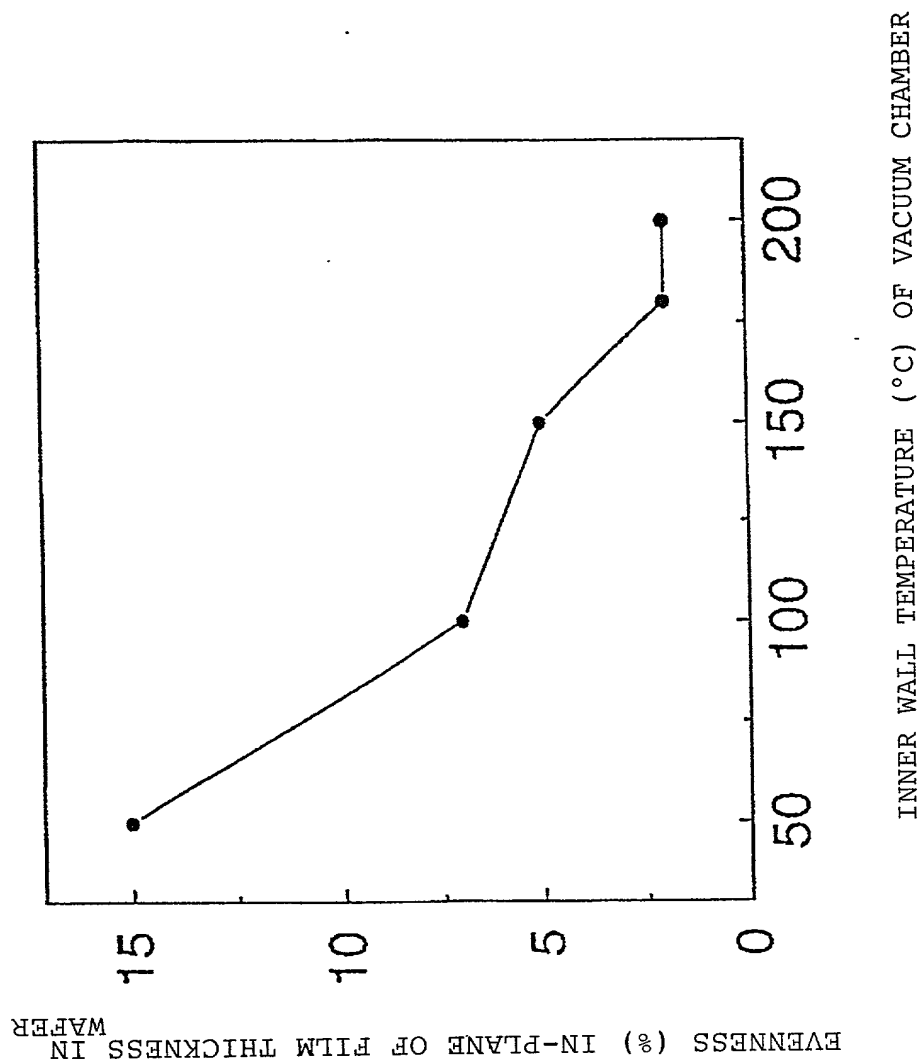
PRESSURE (Torr) AT THE TIME OF FILM FORMATION

EVENNESS (%) IN-PLANE OF FILM THICKNESS IN WAFER

Fig. 16



PRESSURE (Torr) AT THE TIME OF FILM FORMATION



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Fig. 18

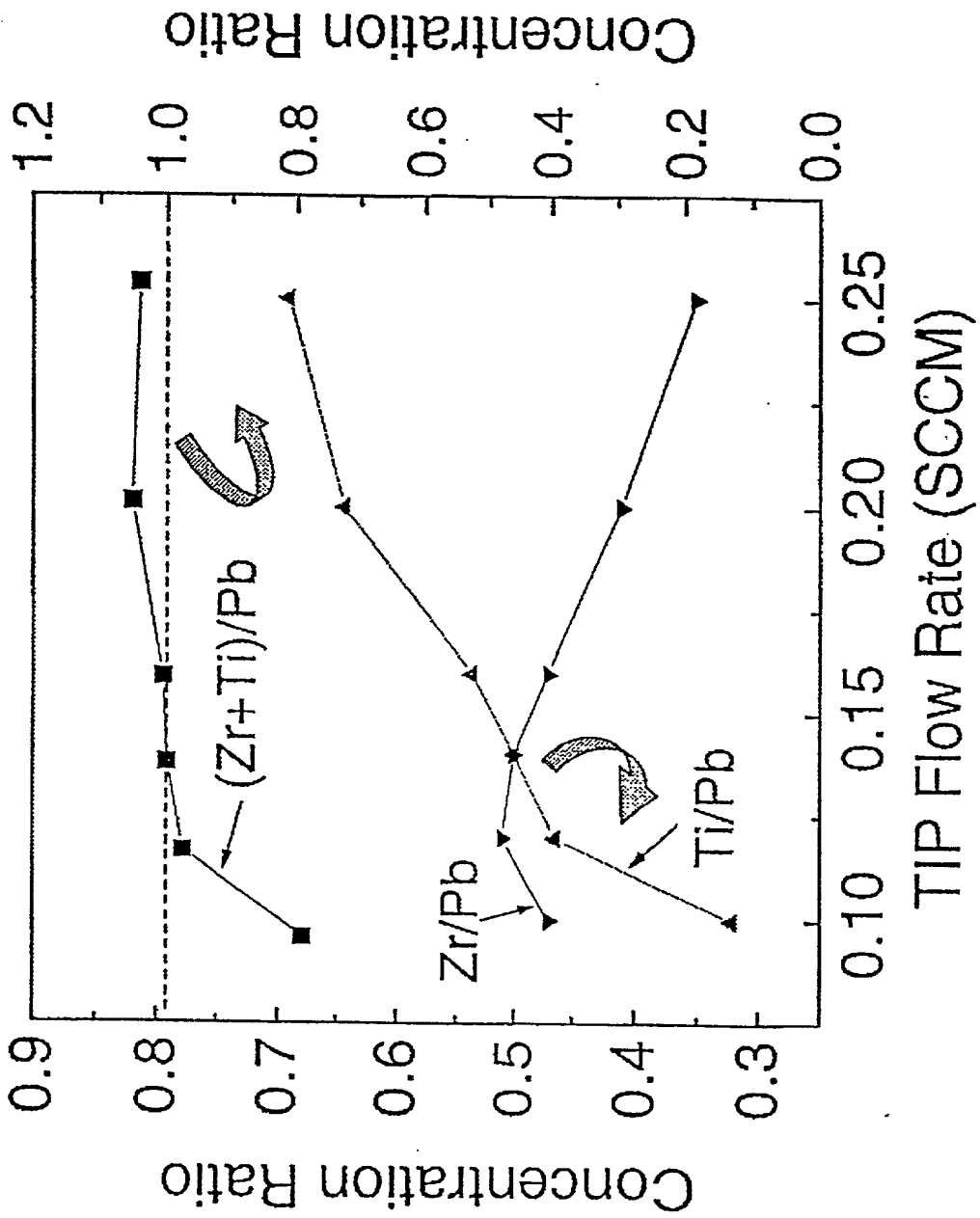


Fig. 19

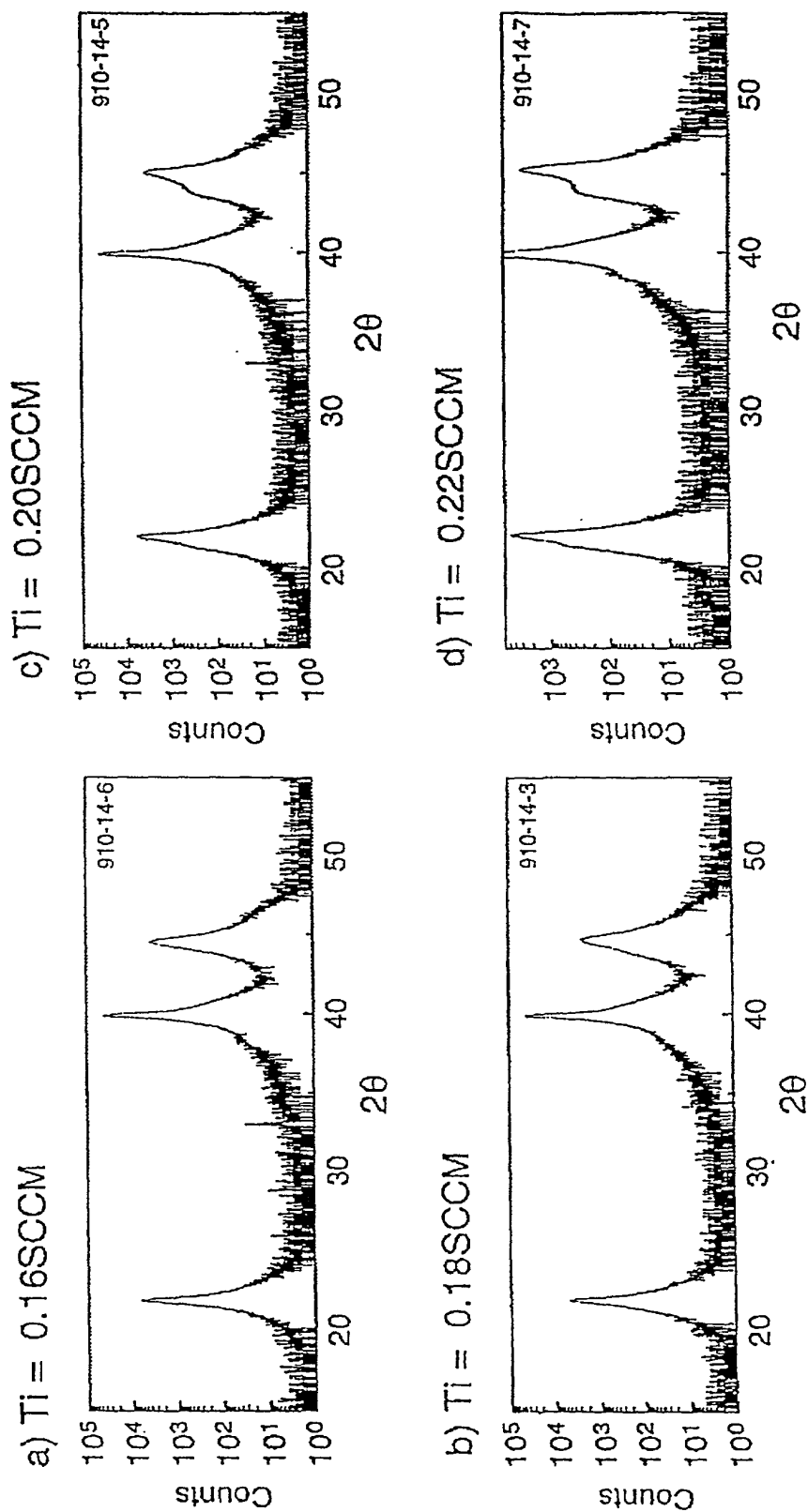
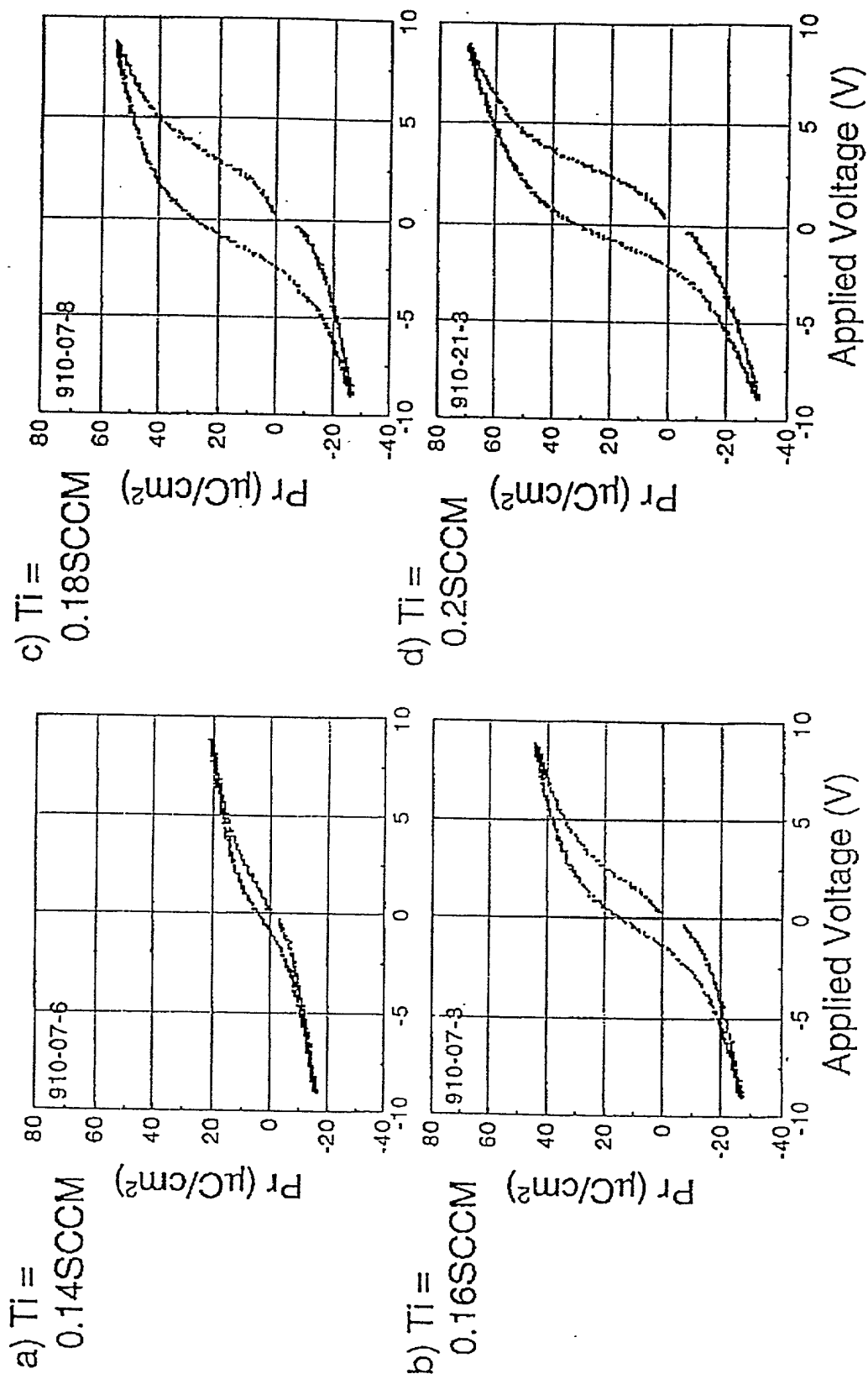
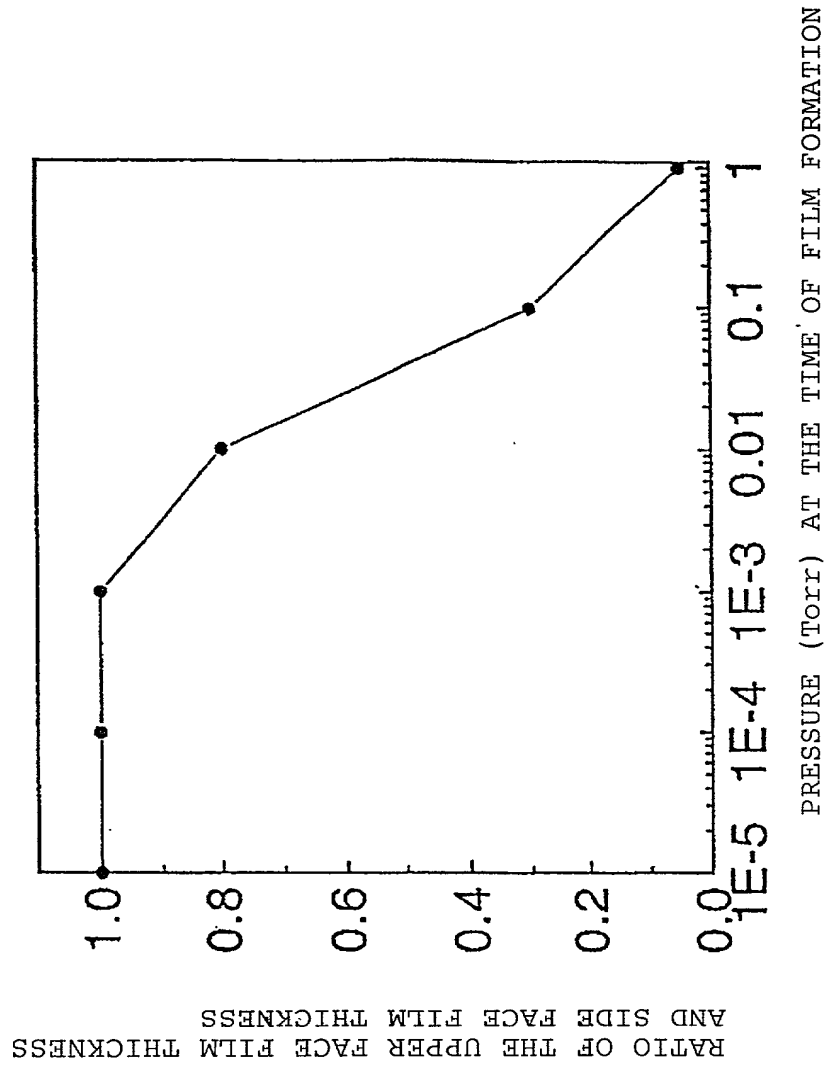


Fig. 20



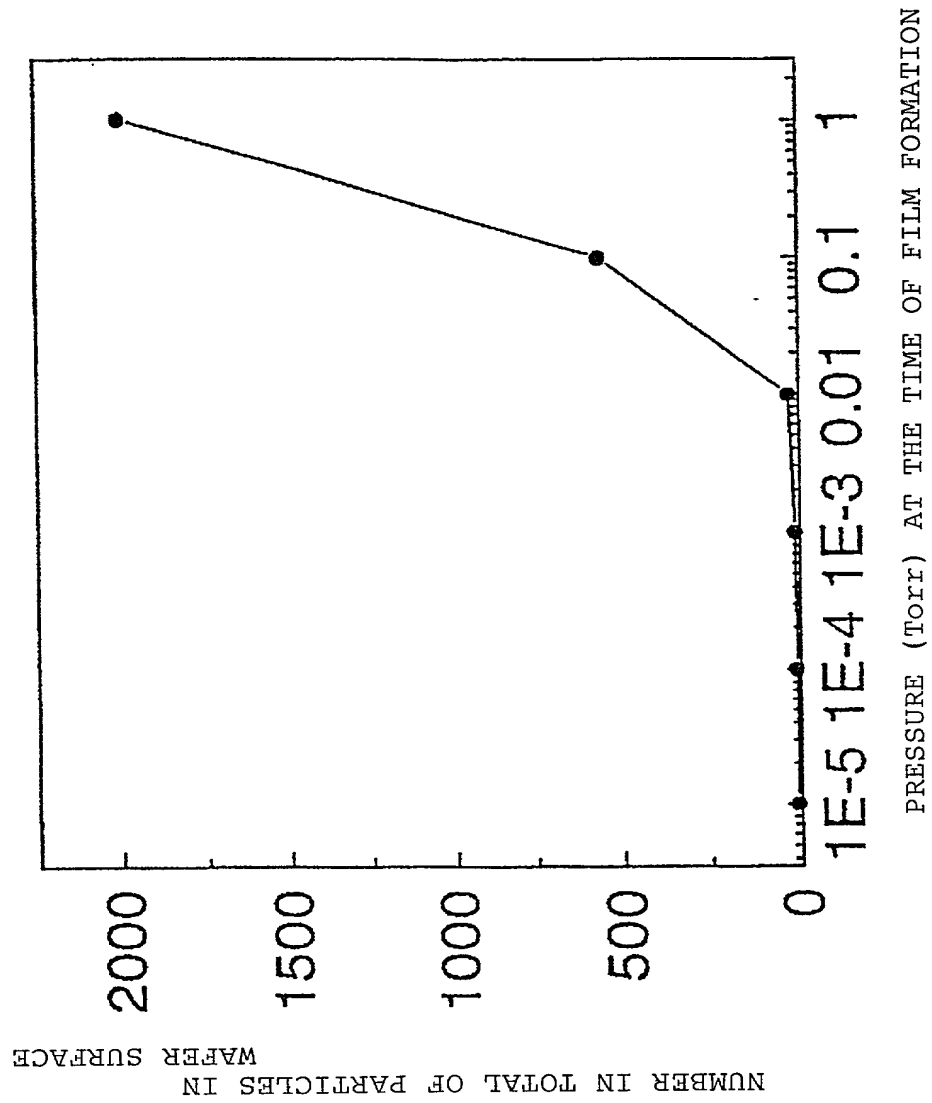
FOOTNOTED TO FIG. 20

Fig. 21



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Fig. 22





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Fig. 23

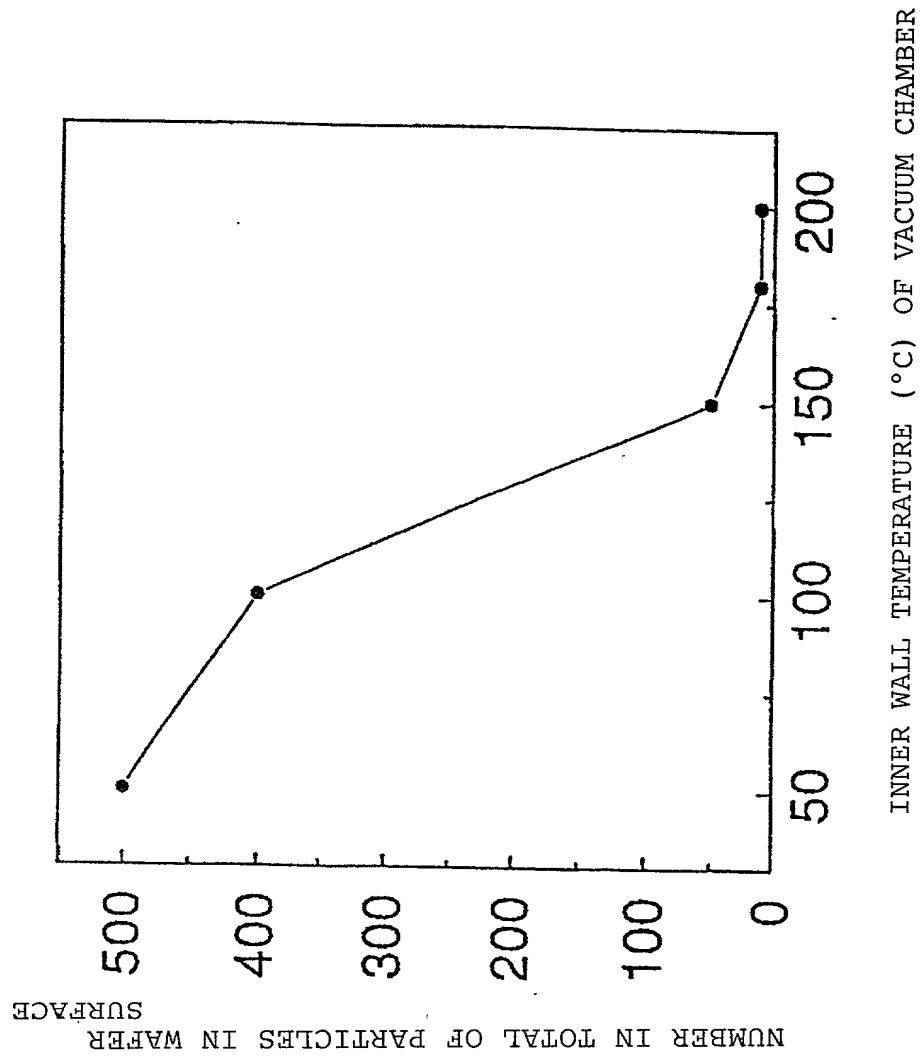


Fig. 24

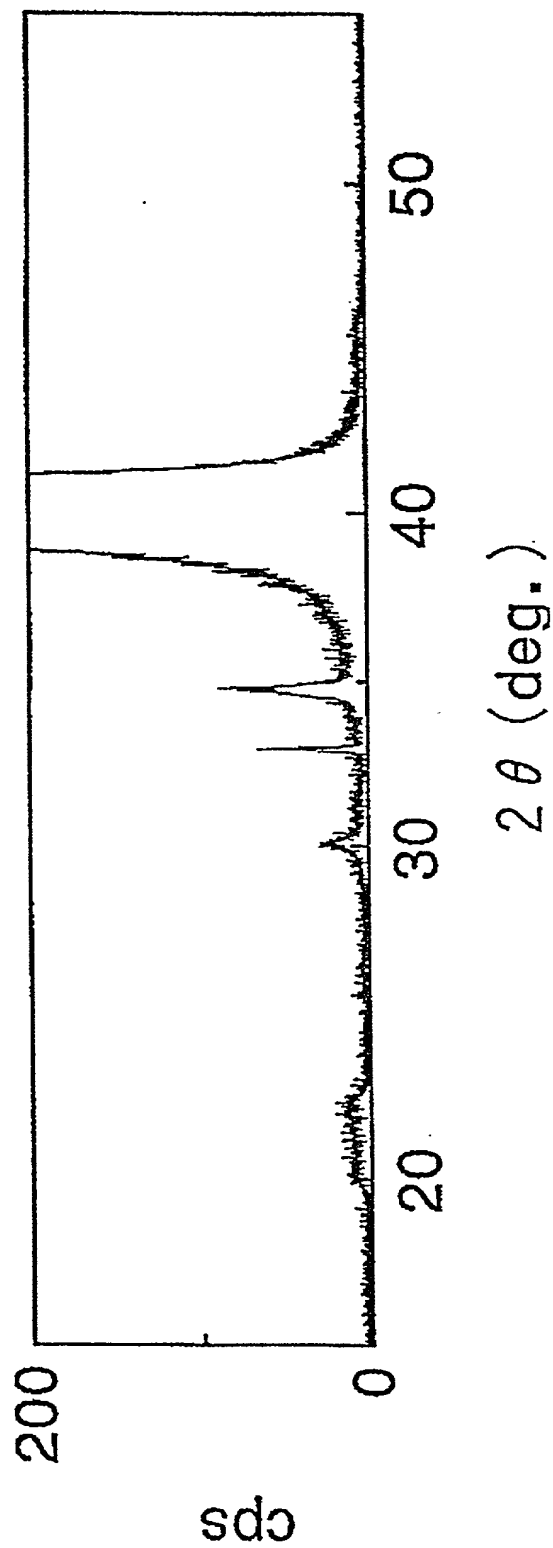
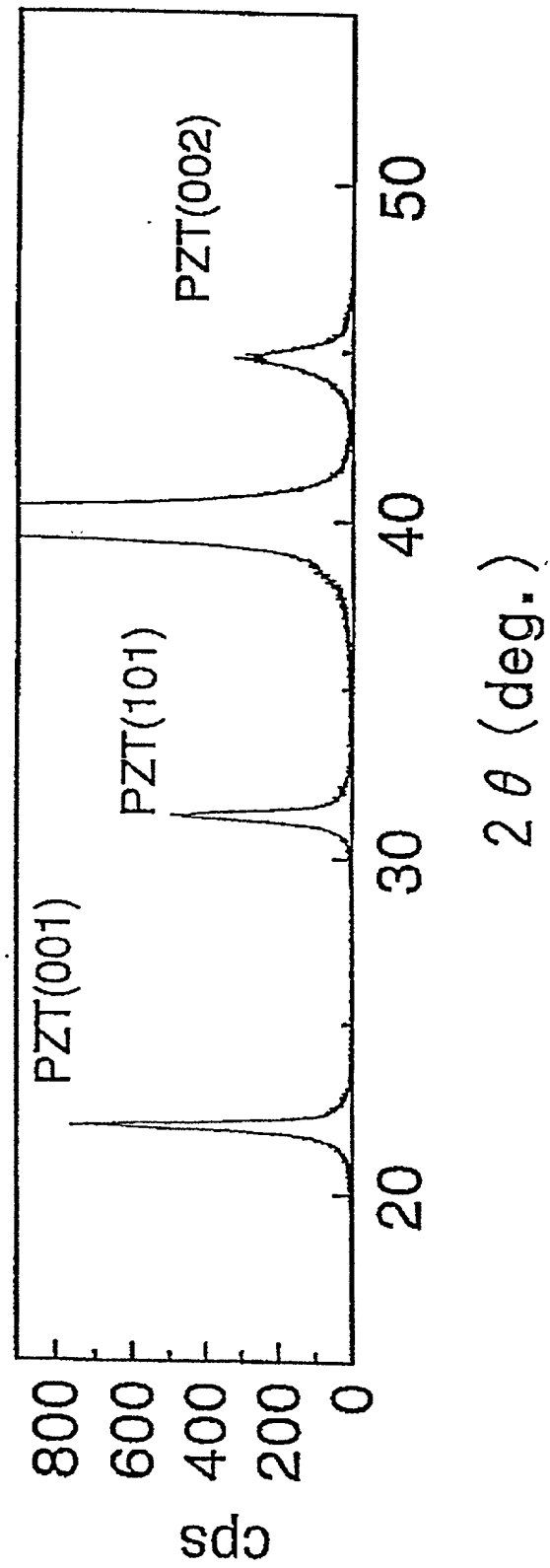
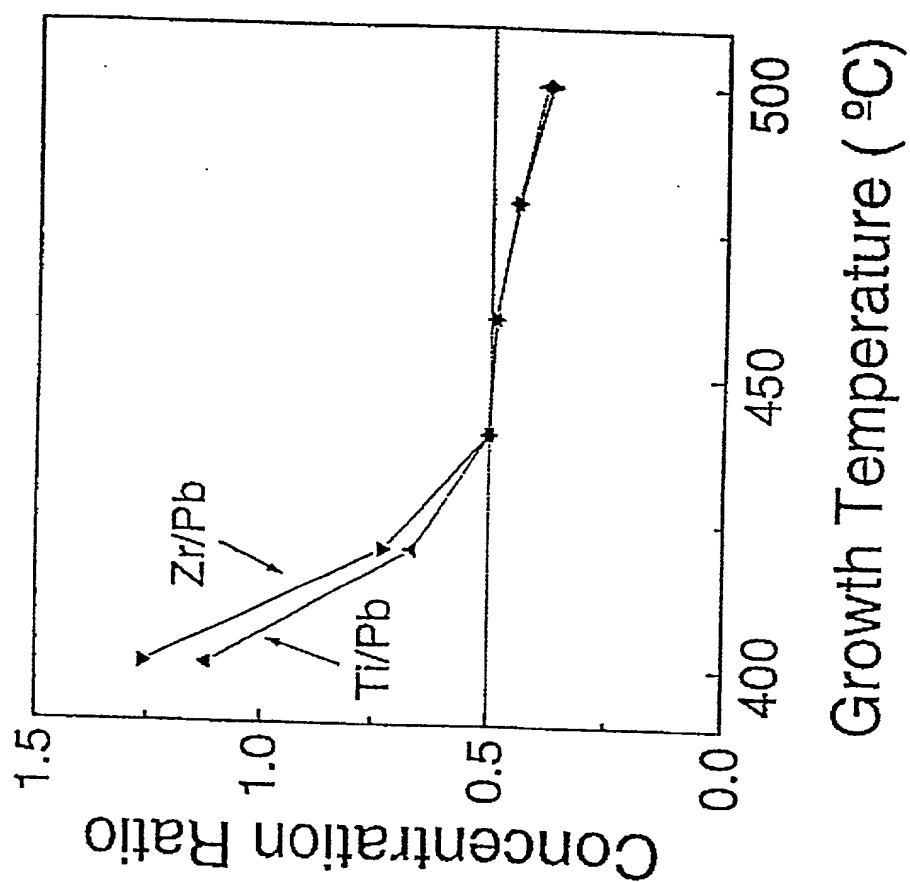


Fig. 25



26/36



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Fig. 27

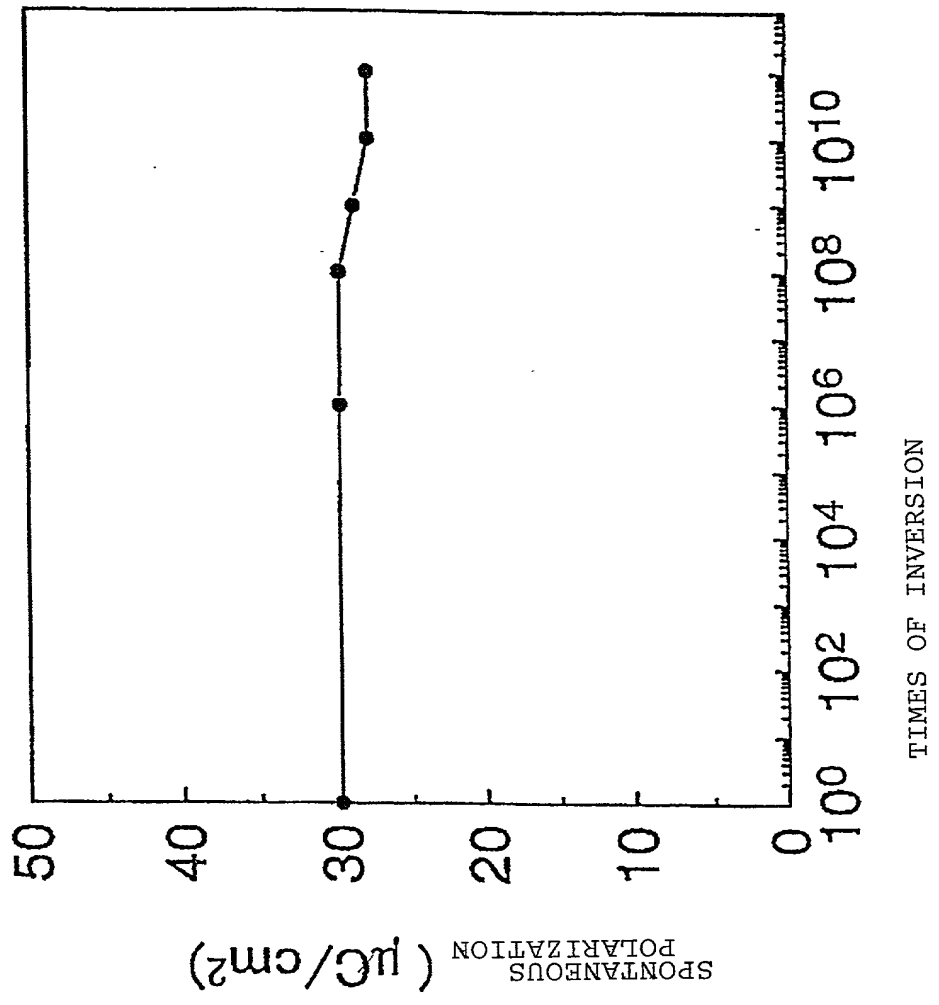


Fig. 28

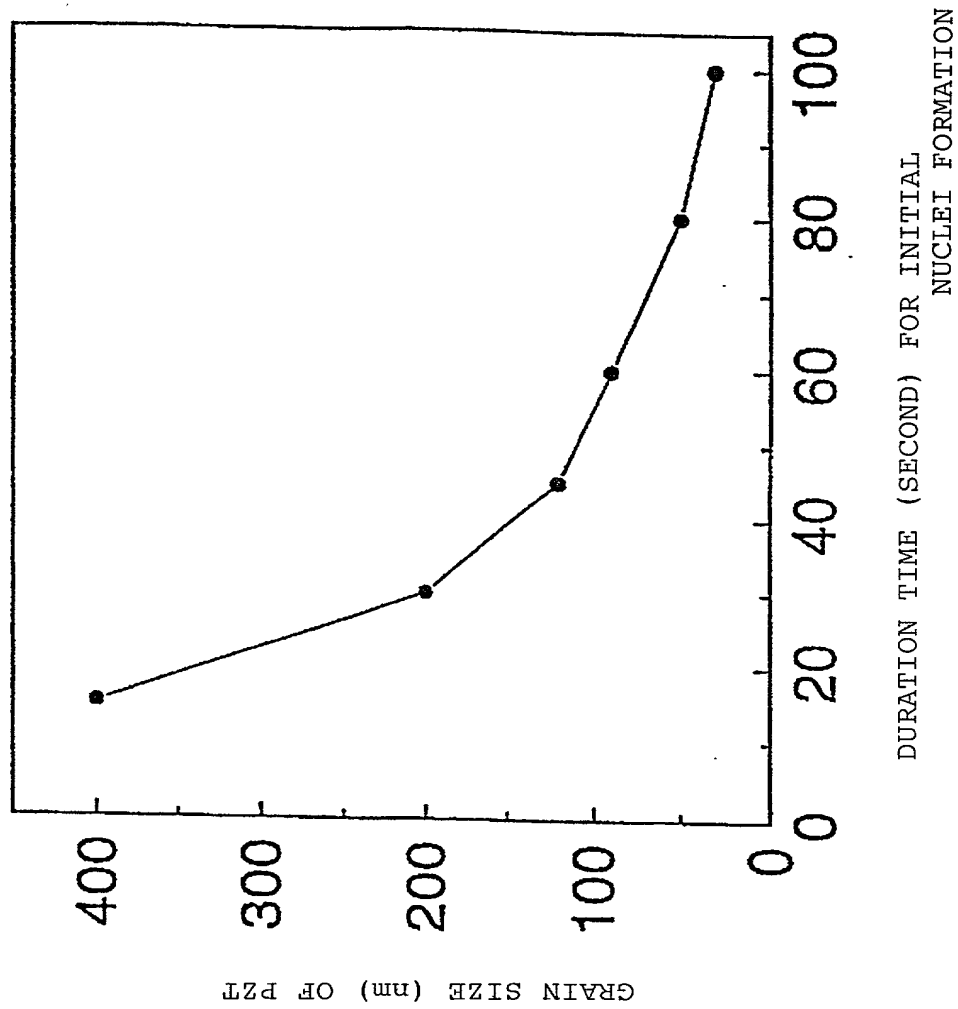


Fig. 29 (A)

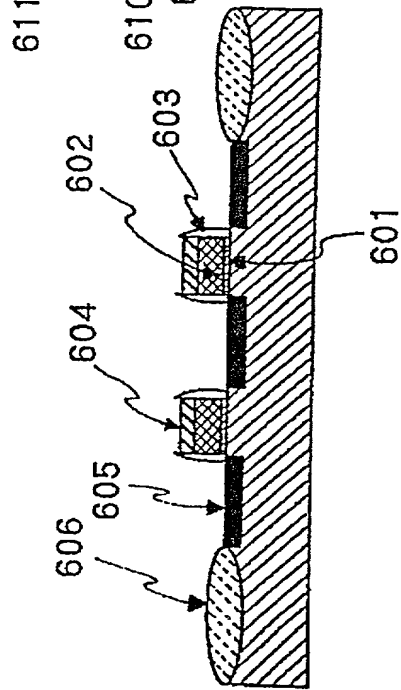


Fig. 29 (B)

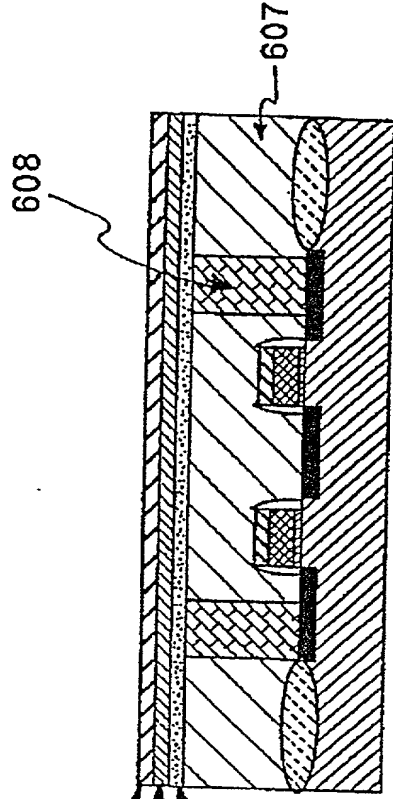


Fig. 29 (C)

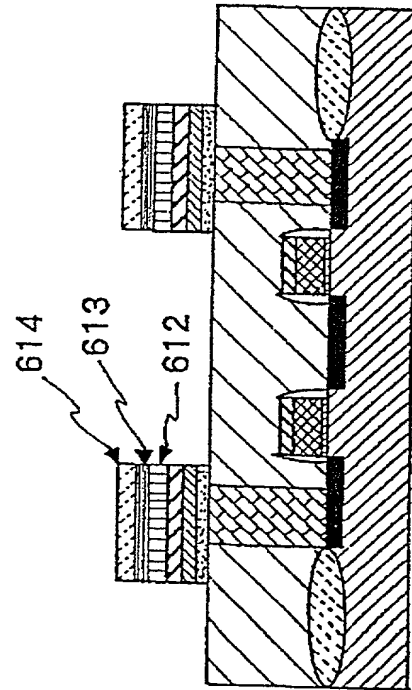


Fig. 29 (D)

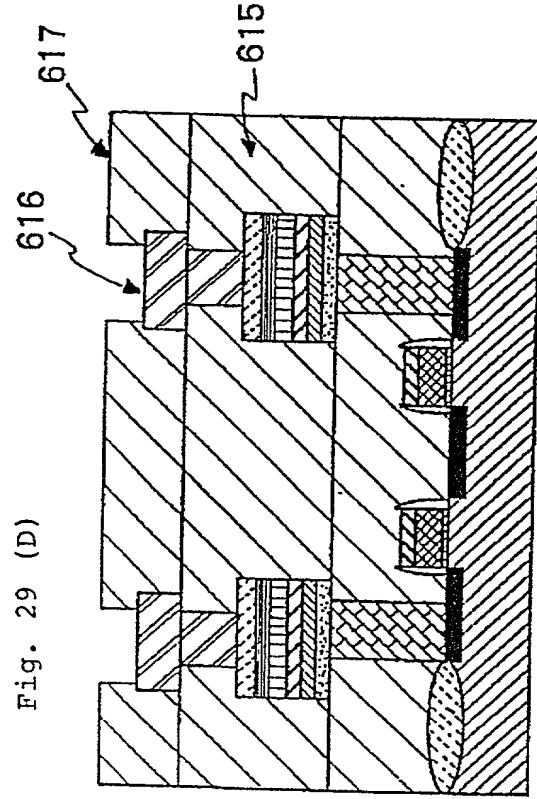


Fig. 30 (A)

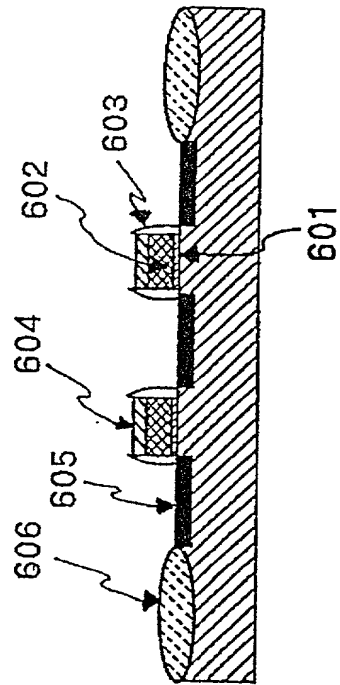


Fig. 30 (B)

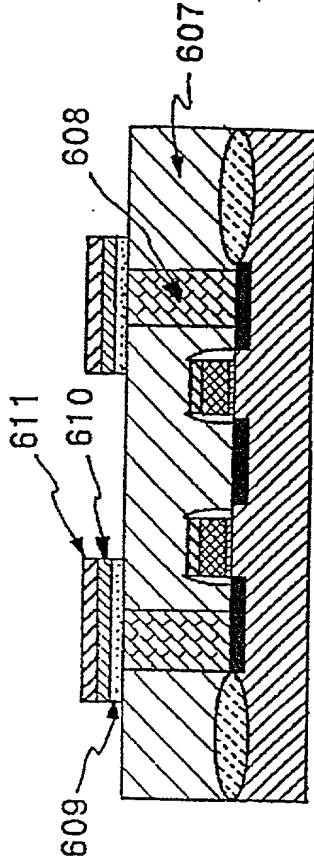


Fig. 30 (C)

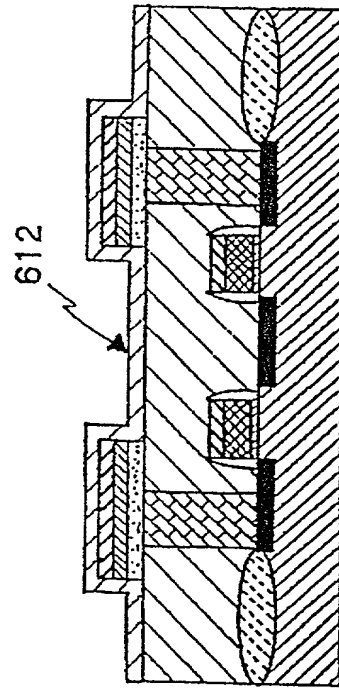


Fig. 30 (D)

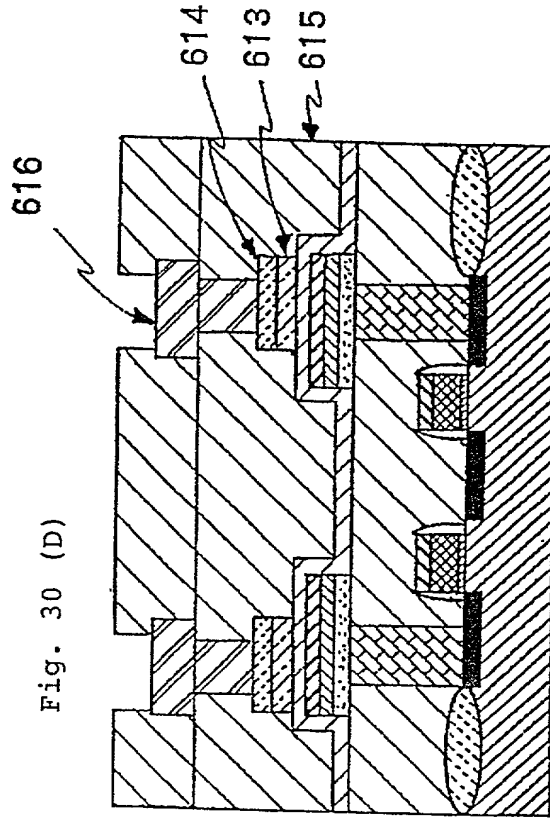




Fig. 31 (A)

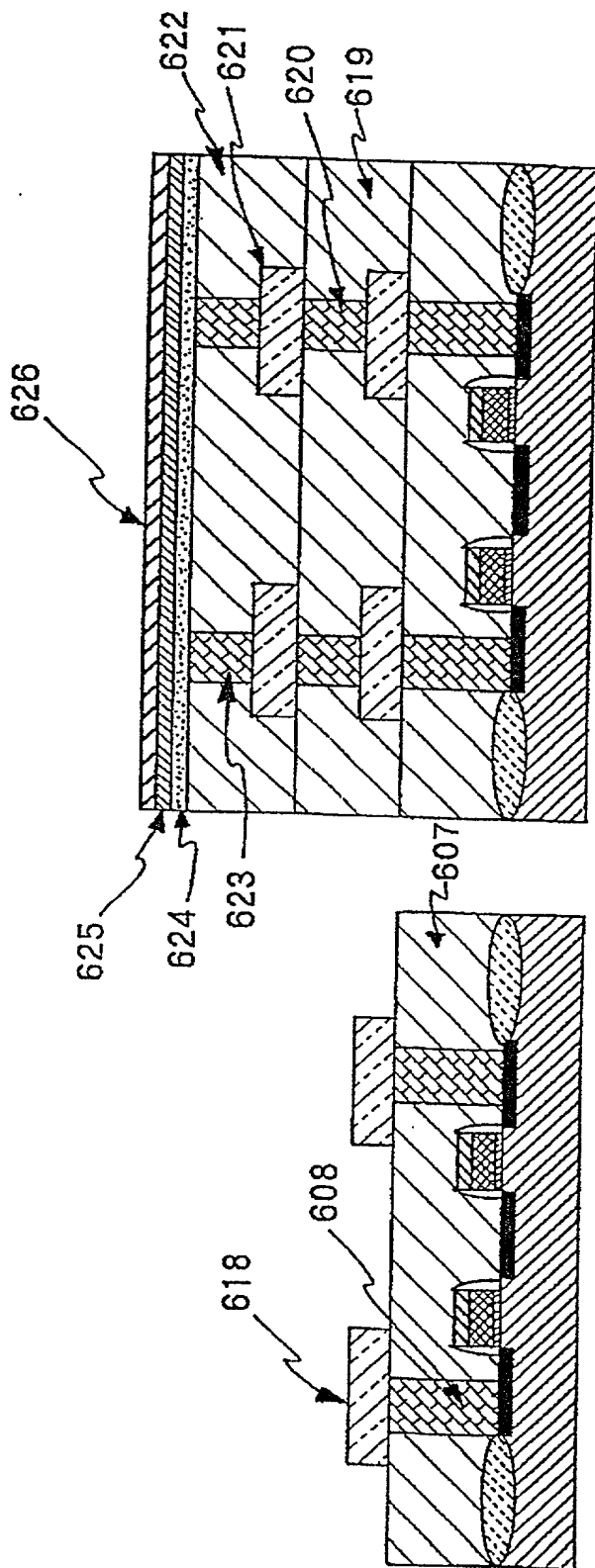


Fig. 31 (B)

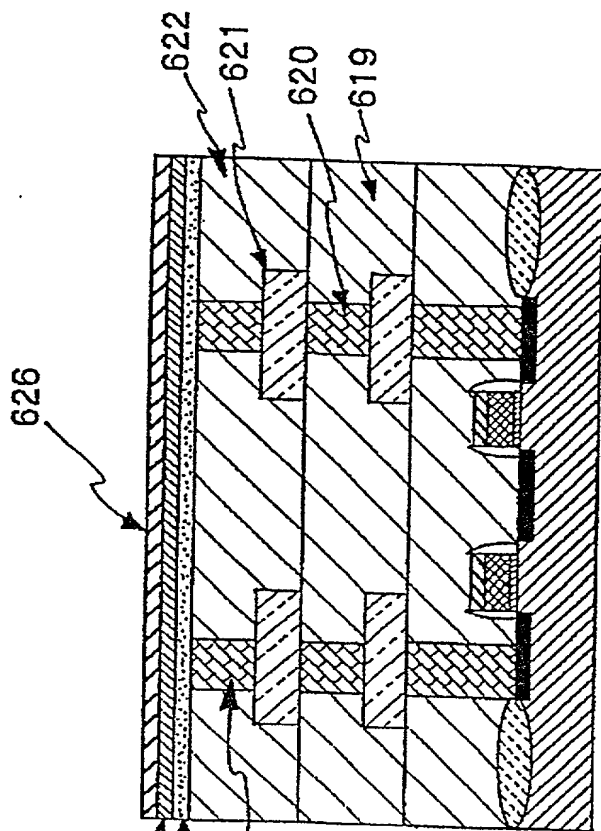


Fig. 32 (D)

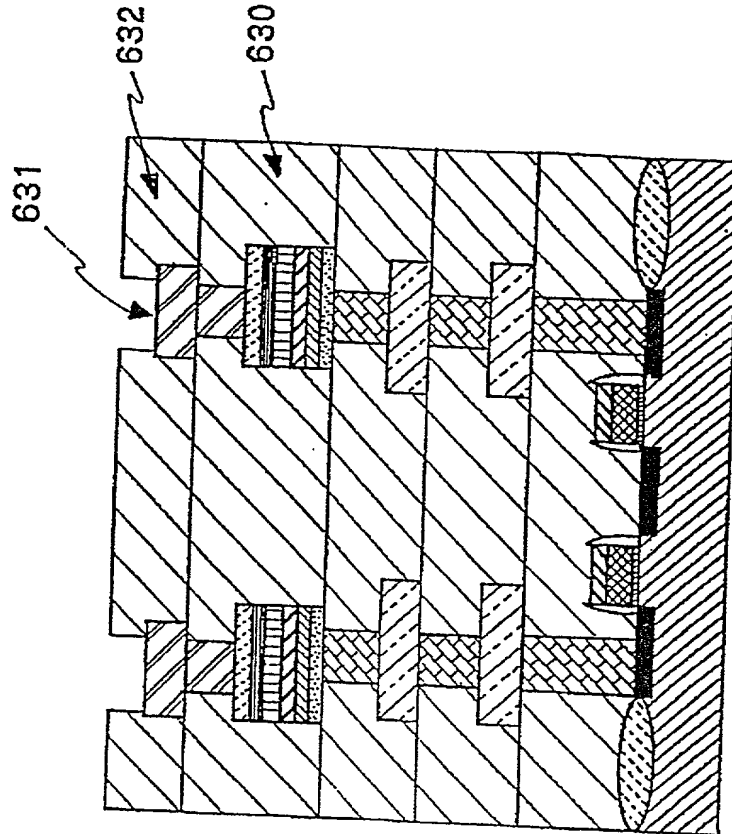


Fig. 32 (C)

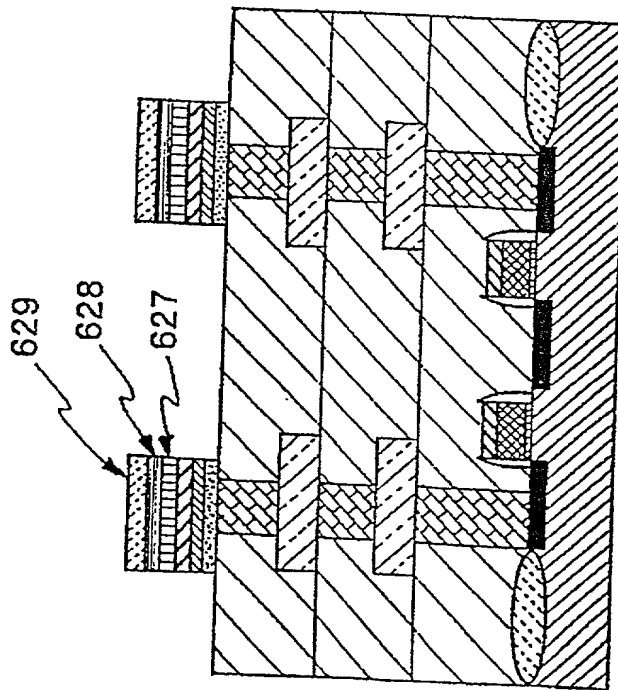


Fig. 33

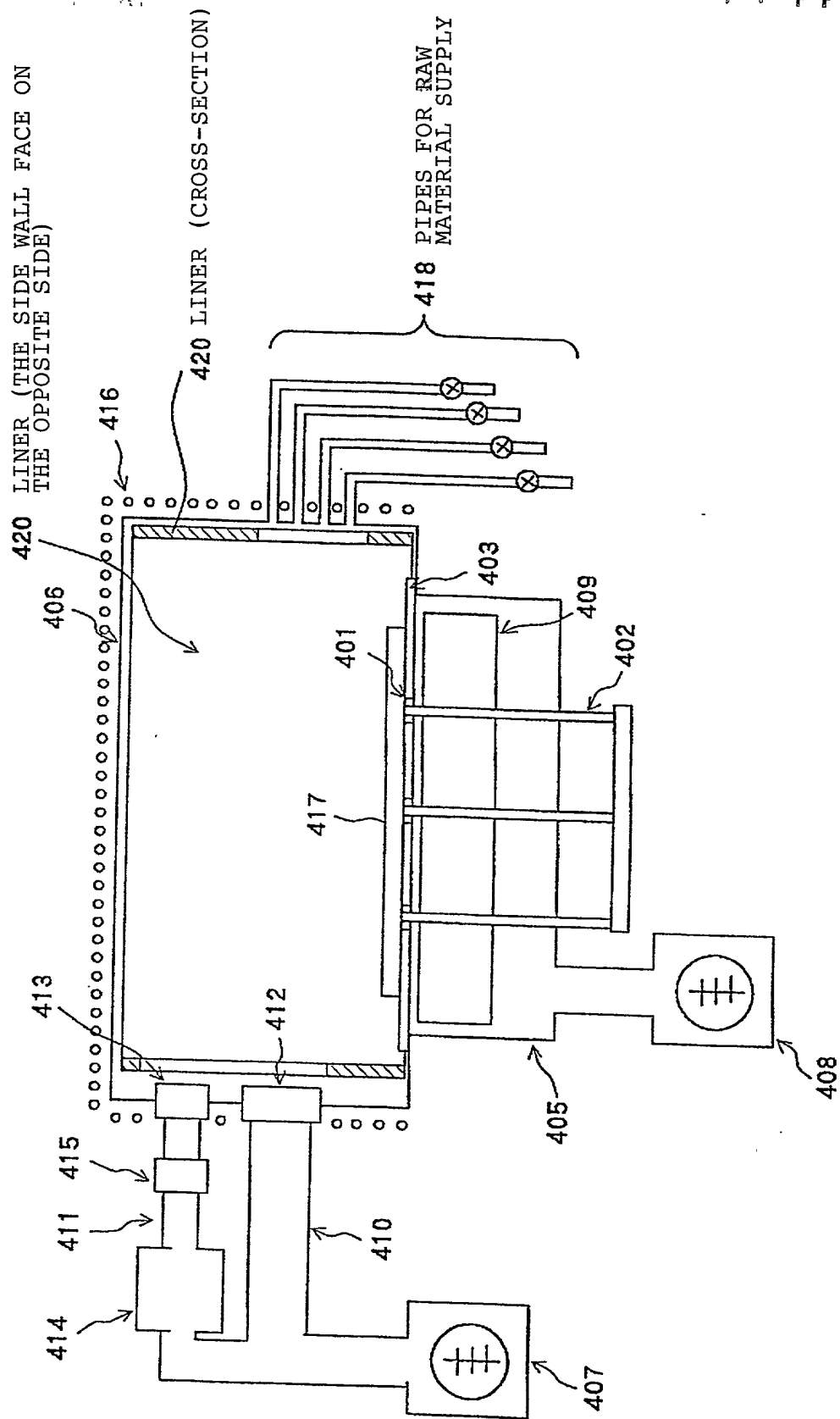


Fig. 34

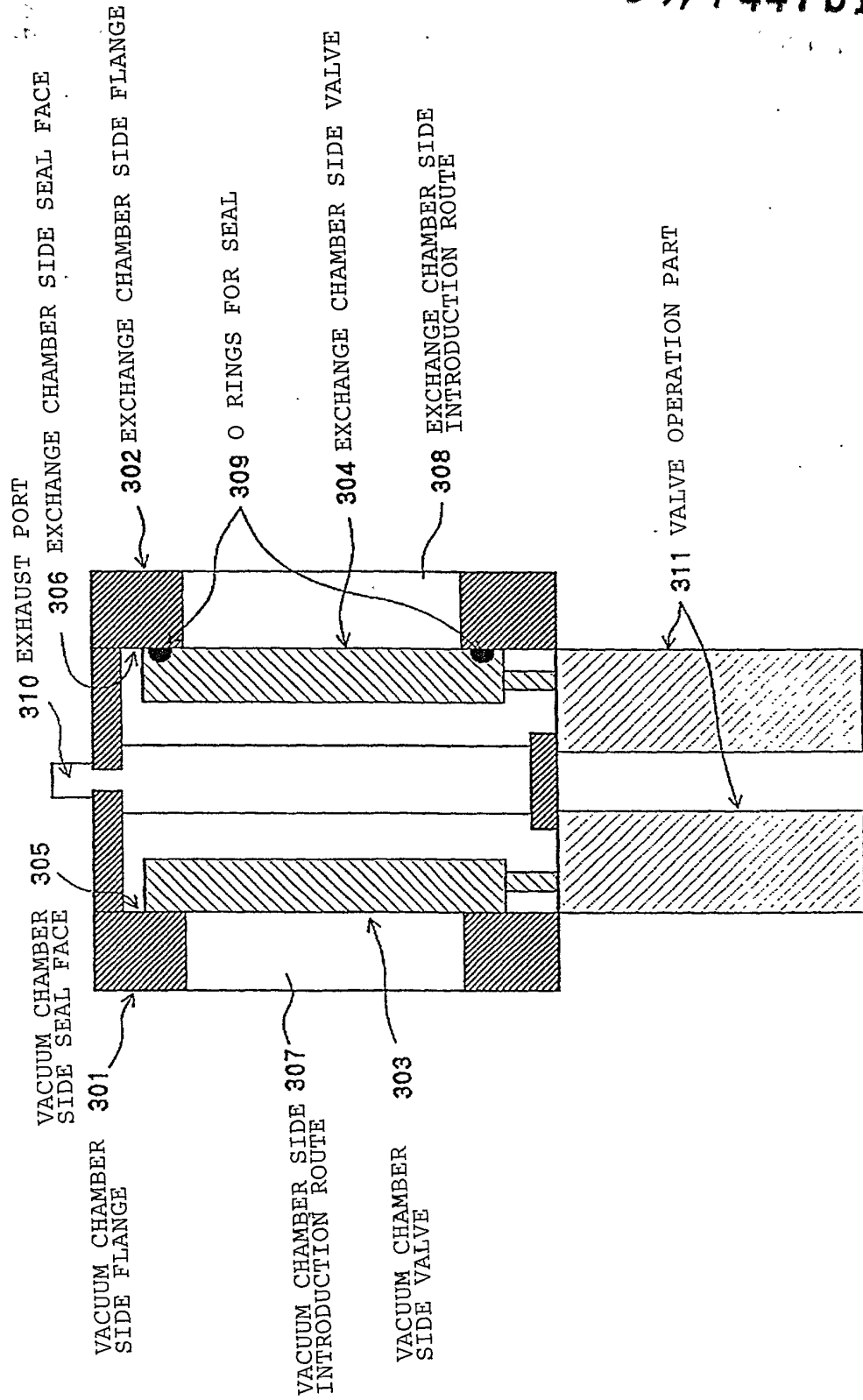


Fig. 35

NUMBER IN TOTAL OF PARTICLES IN WAFER SURFACE

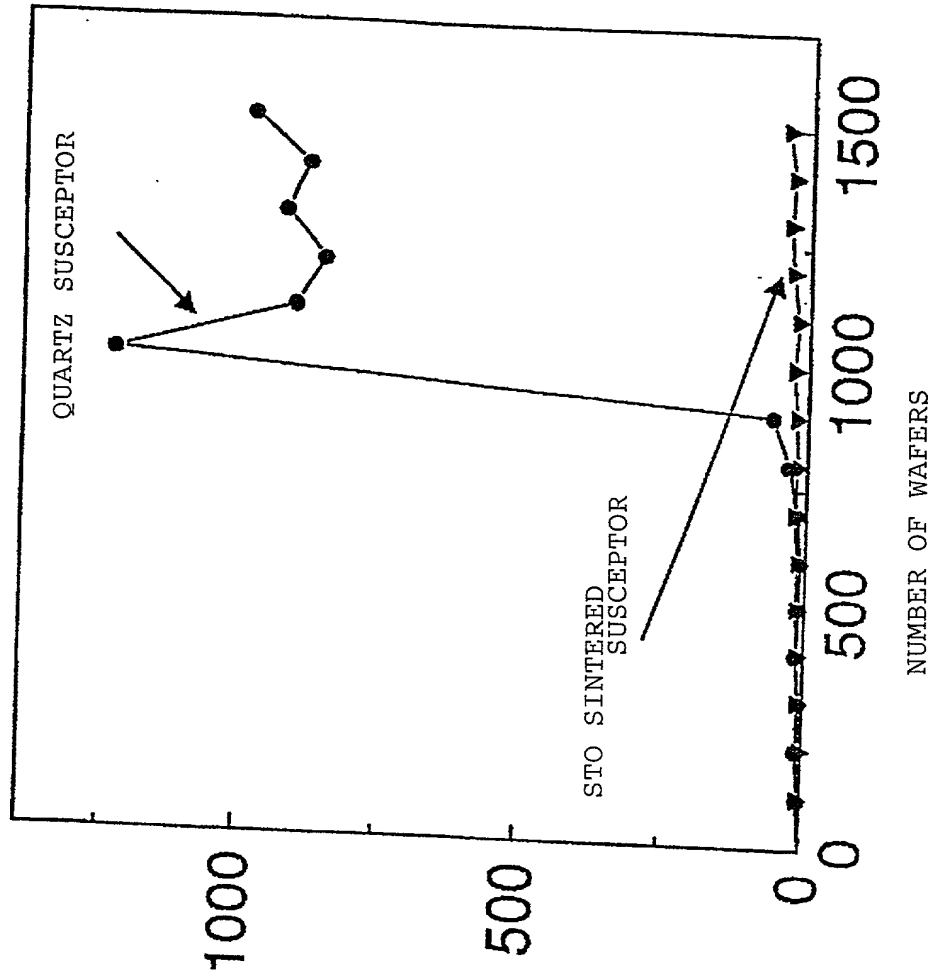
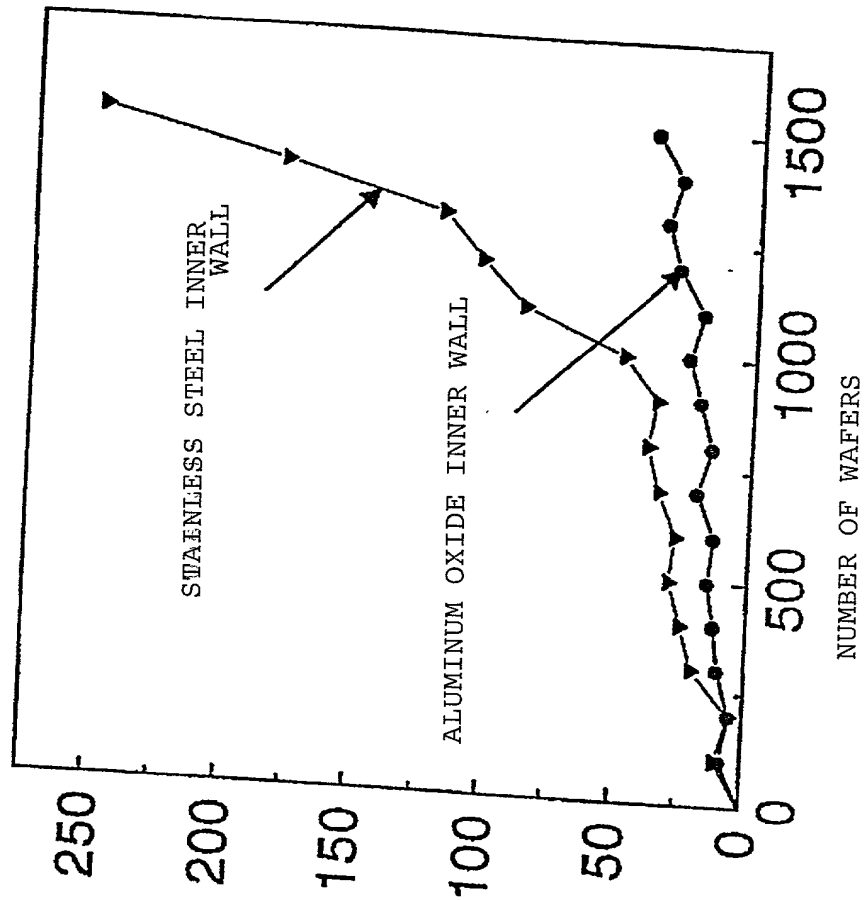


Fig. 36



NUMBER IN TOTAL OF PARTICLES IN WAFER SURFACE

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Attorney Docket No.: NECW 18,281

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Inventors : **Toru TATSUMI, *et al.***  
Filed : **Concurrently Herewith**  
Title : **METHOD OF VAPOR PHASE GROWTH OF METAL  
OXIDE DIELECTRIC FILM AND APPARATUS FOR  
VAPOR PHASE GROWTH OF METAL OXIDE  
DIELECTRIC MATERIAL**

January 29, 2001


Assistant Commissioner for Patents  
Box PCT  
Washington, D.C. 20231

**SUB-POWER OF ATTORNEY**

S I R:

I, Aaron B. Karas, 18,923 attorney of record herein, do hereby grant a sub-power of attorney to Leonard Cooper, Reg. No. 27,625; Harris A. Wolin, Reg. No. 39,432; Linda S. Chan, Reg. No. 42,400; Brian Myers Reg. No. 46,947; Michael Markowitz, Reg. No. 30,659 to act and sign in my behalf in the above-referenced application.

Respectfully submitted

  
Aaron B. Karas; Reg. No. 18,923

HELFGOTT & KARAS, P.C.  
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NEW YORK, NEW YORK 10118-6098  
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DECLARATION FOR PATENT APPLICATION Docket No. NECW 18.281

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled METHOD OF VAPOR PHASE GROWTH OF METAL OXIDE DIELECTRIC FILM AND APPARATUS FOR VAPOR PHASE GROWTH OF METAL OXIDE DIELECTRIC MATERIAL the specification of which

(check one) ☒ is attached hereto.

☐ was filed on \_\_\_\_\_ as

Application Serial No. \_\_\_\_\_

and was amended on \_\_\_\_\_ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by an amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)			Priority Claimed
<u>219183/1998</u>	<u>Japan</u>	<u>03/08/1998</u>	<input checked="" type="checkbox"/> Yes No
(Number)	(Country)	(Day/Month/Year Filed)	
<u>219184/1998</u>	<u>Japan</u>	<u>03/08/1998</u>	<input checked="" type="checkbox"/> Yes No
(Number)	(Country)	(Day/Month/Year Filed)	
<u>219187/1998</u>	<u>Japan</u>	<u>03/08/1998</u>	<input checked="" type="checkbox"/> Yes No
(Number)	(Country)	(Day/Month/Year Filed)	

I hereby claim the benefit under Title 35, United State Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.)	(Filing Date)	(Status - patented, pending, abandoned)
_____	_____	_____
(Application Serial No.)	(Filing Date)	(Status - patented, pending, abandoned)

8 I hereby appoint as my attorney and agent Aaron B. Karas, Reg. No. 18,923, Samson Helfgott, Reg. No. 23,072 and Emma Shleifer, Reg. No. 29,734 to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

Address all correspondence to:

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60th Floor  
Empire State Building  
New York, New York 10118-0110  
Telephone No. (212) 643-5000

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Inventor's signature Toru Tatumi Date January 19, 2001

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Second Inventor's signature Atsushi Yamashita Date January 19, 2001

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